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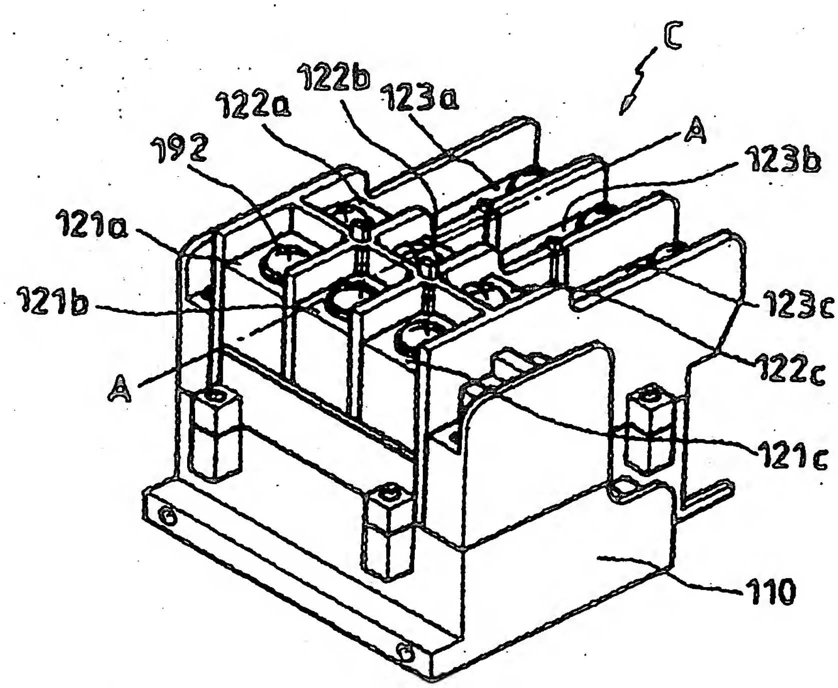
(57) Abstract



Disclosed is an electromagnetic switch device for star–delta connections including a body, three power terminals respectively connected to three–phase power lines at one side of the body, three main starting terminals respectively connected to one–side terminals of a three–phase electric motor at the other side of the body, three star–delta terminals respectively connected to the other–side ends of the three–phase electric motor at the other side of the body, an electromagnet for a main circuit and an electromagnet for star–delta connections disposed at a lower portion of the body in such a fashion that they are laterally aligned with each other, each of the electromagnets including a fixed core and a coil wound around the fixed core, a main circuit switching unit serving to selectively connect each of the main starting terminals to an associated one of the power terminals in accordance with a magnetization of the main circuit–end electromagnet, and a star–delta connection switching unit serving to selectively connect the star–delta terminals to one another or to the main starting terminals, respectively, in accordance with a magnetization of the star–delta connection–end electromagnet.

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A MAGNETIC CONTACTOR FOR STAR-DELTA CONNECTIONS

Technical Field

The present invention relates to a magnetic contactor(electromagnetic switch device) for star-delta connections, and more particularly to an electromagnetic switch device designed to be used for a star-delta starter adapted to start up a three-phase electric motor in order to allow the motor to be driven at its full speed within a short period of time.

Background Art

As well known, star (Y)-delta (Δ) starters, which are used to start up an electric motor, serve to establish a star connection for the electric motor upon the start-up of the electric motor, thereby reducing starting current and starting torque required in the start-up of the electric motor to a 1/3 level, while switching the connection for the electric motor into a delta connection after completion of the start-up of the electric motor so that the electric motor is driven in the delta connection state. Such star-delta starters are widely used in a variety of industrial fields in order to protect electric motors and peripheral devices thereof from overload.

Star-delta starters are classified into a contact type using an electromagnetic switch device adapted to switch

electric contacts by use of electromagnets, and a non-contact type using a semiconductor switch device. The type using an electromagnetic switch device is more widely used.

Figs. 1a, 1b and 2 illustrate a conventional electromagnetic switch device and a star-delta starter using the electromagnetic switch device, respectively. Fig. 1a is a perspective view illustrating the electromagnetic switch device, and Fig. 1b is a cross-sectional view taken along the line A - A of Fig. 1a. Fig. 2 is an equivalent circuit diagram illustrating the star-delta starter.

As shown in Figs. 1a and 1b, the conventional electromagnetic switch device, which is denoted by the reference character C, includes a body 1, and a cover 2 separably attached to an upper surface 1a of the body 1. Three pairs of terminals 3 are disposed on the upper surface 1a of the body 1 in such a fashion that the terminals of each terminal pair are arranged at opposite sides of the body 1, respectively, while being insulated from one another. Electric power lines not shown are connected to the terminals 3, respectively. Isolating plates 4 are arranged at opposite sides of the cover 2 to isolate adjacent ones of the terminals 3.

Three pairs of fixed contacts 5 are also provided. Each fixed contact 5 is arranged at an end of an associated one of the terminals 3 extending toward a central portion of the body 1. The fixed contacts 5 are insulated from one another. A

vertical moving member 6 is arranged at the central portion of the body 1 in such a fashion that it is upwardly and downwardly movable. Three pairs of moving contacts 7 insulated from one another are mounted to the vertical moving member 6 at opposite sides of the vertical moving member 6 in such a fashion that each of the moving contacts 7 selectively comes into contact with an associated one of the fixed contacts 5 so that it is short-circuited or opened with respect to the associated fixed contact 5. A compression coil spring 8 is arranged around the vertical moving member 6 between the upper surface 1a of the body 1 and the moving contacts 7 in such a fashion that it always urges the vertical moving member 6 upwardly.

A fixed core 9 is arranged at a lower portion of the body 1. A coil 10 is wound around the fixed core 9 in order to form an electromagnet. Above the fixed core 9, a moving core 11 is arranged in such a fashion that it moves vertically along with the vertical moving member 6 in accordance with a magnetization of the electromagnet.

The conventional star-delta starter using electromagnetic switch devices having the above mentioned configuration includes an electromagnetic switch device C1 for a main circuit, an electromagnetic switch device C2 for a star circuit, and an electromagnetic switch device C3 for a delta connection, which are connected together as shown in the equivalent circuit diagram of Fig. 2 and activated by a timer (not shown) to start

up a three-phase electric motor M.

When current flows through the coil 10 of the electromagnetic switch device C2 for the star circuit upon starting the three-phase electric motor M, the electromagnet formed by the fixed core 9 and coil 10 is magnetized by virtue of the current.

Accordingly, the electromagnet generates a magnetic force greater than the resilience of the spring 8, so that the vertical moving member 6 and moving core 11 are downwardly moved. As a result, the moving contacts 7, which also move downwardly, come into contact with the fixed contacts 5, respectively.

When the electromagnetic switch device C1 for the main circuit is activated in accordance with the same procedure as mentioned above, a star connection is established for the three-phase electric motor M, so that the three-phase electric motor M is started up using starting current and starting torque reduced to a 1/3 level. At the same time, the timer not shown begins to operate in order to count the drive time of the three-phase electric motor M.

After a predetermined period of time elapses, the current flowing through the coil 10 of the electromagnetic switch device C2 for the star connection is cut off by an operation of the timer. At the same time, current flows through the coil 10 of the electromagnetic switch device C3 for the delta connection.

In this state, the magnetic force of the electromagnet formed by the fixed core 9 and coil 10 of the electromagnetic switch device C2 for the star connection disappears. As a result, the vertical moving member 6 is upwardly moved along with the moving core 11 and moving contacts 7 by virtue of the resilience of the spring 8, thereby causing the moving contacts 7 to be separated from the fixed contacts 5.

Meanwhile, the electromagnet formed by the fixed core 9 and coil 10 of the electromagnetic switch device C3 for the delta connection is magnetized by virtue of the current flowing through the coil 10. As a result, the moving contacts 7 are downwardly moved, so that they come into contact with the fixed contacts 5, respectively.

Accordingly, the electromagnetic switch device C3 for the delta connection is short-circuited to electric power lines at its one-side terminals 3. As a result, the three-phase electric motor M is switched to the star connection state to a delta connection state, so that it is driven at a full speed.

In the star-delta starter having the above mentioned configuration, each of its electromagnetic switch devices is used only for a single purpose, that is, a star connection or a delta connection. For this reason, the conventional star-delta starter cannot implement a desired system unless at least two electromagnetic switch devices are used, even when those used for the main circuit are not taken into consideration.

As a result, the conventional star-delta starter involves high manufacturing and installing costs and a large occupation space.

The conventional star-delta starter also involves a complex wiring for the connection between the electric motor and the electromagnetic switch device used. Such a complex wiring may result in a possibility of erroneous connections. In particular, such a wiring may be easily damaged by an external force applied thereto, thereby resulting in an erroneous operation of the starter or a damage of the electric motor.

Disclosure of Invention

Therefore, an object of the invention is to solve the above mentioned problems involved in the prior art, and to provide an electromagnetic switch device for star-delta connections which includes two electromagnets arranged in its body and two switching units operating in accordance with respective magnetization states of the electromagnets in order to selectively establish a star connection or a delta connection for a three-phase electric motor, so that it can reduce installation costs and an occupation space when it is applied to a star-delta starter while using no unnecessary wiring, thereby reducing erroneous connections and erroneous operations.

In accordance with the present invention, this object is accomplished by providing an electromagnetic switch device for

star-delta connections comprising: a body; three power terminals arranged at one side of the body and respectively connected to three-phase power lines, the power terminals being insulated from one another; three main starting terminals arranged at the other side of the body and respectively connected to one-side terminals of a three-phase electric motor, the main starting terminals being insulated from one another; three star-delta terminals arranged at the other side of the body outside the main starting terminals and connected to the other-side ends of the three-phase electric motor, respectively, the star-delta terminals being insulated from one another; an electromagnet for a main circuit and an electromagnet for star-delta connections disposed at a lower portion of the body in such a fashion that they are laterally aligned with each other while being insulated from each other, each of the electromagnets including a fixed core and a coil wound around the fixed core; a main circuit switching unit arranged near the main circuit-end electromagnet in the interior of the body, the main circuit switching unit serving to selectively connect each of the main starting terminals to an associated one of the power terminals in accordance with a magnetization of the main circuit-end electromagnet; and a star-delta connection switching unit arranged near the star-delta connection-end electromagnet in the interior of the body, the star-delta connection switching unit serving to selectively connect the star-delta terminals to one

another or to the main starting terminals, respectively, in accordance with a magnetization of the star-delta connection-end electromagnet.

Preferably, the electromagnetic switch device further comprises a timer arranged in the interior of the body and adapted to count an activation time of the main circuit-end electromagnet, thereby determining a point of time when the star-delta connection-end electromagnet is to be activated.

The electromagnetic switch device may further comprise isolating plates arranged between adjacent ones of the power terminals, between adjacent ones of the main starting terminals, and between adjacent ones of the star-delta terminals to isolate the adjacent power terminals, the adjacent main starting terminals, and the adjacent star-delta terminals, respectively.

The main circuit switching unit may comprise: a moving core vertically movable in accordance with a magnetization of the main circuit-end electromagnet; a vertical moving member integrally coupled to the moving core in such a fashion that it is moved along with the moving core; three pairs of fixed contacts arranged at desired positions within a vertical movement zone of the vertical moving member in such a fashion that the fixed contacts included in each of the fixed contact pairs are disposed at opposite sides of the vertical moving member, respectively, the fixed contacts arranged at one side of the vertical moving member being connected to the power

terminals, respectively, while being insulated from one another, and the fixed contacts arranged at the other side of the vertical moving member being connected to the main starting terminals, respectively, while being insulated from one another; and three pairs of moving contacts mounted to the vertical moving member in such a fashion that the moving contacts included in each of the moving contact pairs are disposed at opposite sides of the vertical moving member, respectively, the moving contacts arranged at one side of the vertical moving member being insulated from one another, the moving contacts arranged at the other side of the vertical moving member being insulated from one another, and the moving contacts being vertically moved in accordance with a vertical movement of the vertical moving member, so that they selectively come into contact with respective associated ones of the fixed contacts, thereby causing the power terminal-end fixed contacts to be selectively connected to the starting terminal-end fixed contacts.

The star-delta connection switching unit may comprise: a moving core vertically movable in accordance with a magnetization of the star-delta connection-end electromagnet; a vertical moving member integrally coupled to the moving core in such a fashion that it is moved along with the moving core; three pairs of fixed contacts for star-delta connection arranged at desired positions within a vertical movement zone of the

vertical moving member in such a fashion that the fixed contacts included in each of the fixed contact pairs are disposed at opposite sides of the vertical moving member, respectively, the fixed contacts arranged at one side of the vertical moving member being connected to the main starting terminals, respectively, while being insulated from one another, and the fixed contacts arranged at the other side of the vertical moving member being connected to the star-delta terminals, respectively, while being insulated from one another; three pairs of moving contacts for delta connection mounted to the vertical moving member in such a fashion that the moving contacts included in each of the moving contact pairs are disposed at opposite sides of the vertical moving member, respectively, the moving contacts arranged at one side of the vertical moving member being insulated from one another, the moving contacts arranged at the other side of the vertical moving member being insulated from one another, and the moving contacts being vertically moved in accordance with a vertical movement of the vertical moving member, so that they selectively come into contact with respective associated ones of the fixed contacts, thereby causing the star-delta connection-end fixed contacts to be selectively connected to the starting terminal-end fixed contacts so as to achieve a delta connection; and three moving contacts for star connection mounted to the vertical moving member at a position vertically shifted from the

delta connection-end moving contacts near the star-delta connection-end fixed contacts, the star connection-end moving contacts being short-circuited together, and the star connection-end moving contacts being vertically moved in accordance with a vertical movement of the vertical moving member, so that they selectively come into contact with respective associated ones of the fixed contacts, thereby causing the fixed contacts to be selectively connected together so as to achieve a star connection, the star connection by the star connection-end moving contacts being achieved when the delta connection by the delta connection-end moving contacts is released.

Each of the main circuit switching unit and star-delta connection switching unit may further comprise a return springs adapted to provide a return force for returning the associated vertical moving member to an original position thereof at which the associated moving contacts are separated from respective associated ones of the fixed contacts.

Each of the main circuit switching unit and star-delta connection switching unit may further comprise an arc prevention spring arranged in the associated vertical moving member and adapted to always urge the associated moving contacts toward the associated fixed contacts, thereby increasing the contact force of the moving contacts when the moving contacts come into contact with the fixed contacts, so as to suppress generation of

arc at regions where the moving contacts come into contact with the fixed contacts, respectively.

Brief Description of Drawings

The above objects, and other features and advantages of the present invention will become more apparent after a reading of the following detailed description when taken in conjunction with the drawings, in which:

Figs. 1a, 1b and 2 illustrate a conventional electromagnetic switch device and a star-delta starter using the electromagnetic switch device, respectively, wherein Fig. 1a is a perspective view illustrating the electromagnetic switch device, Fig. 1b is a cross-sectional view taken along the line A – A of Fig. 1a, and Fig. 2 is an equivalent circuit diagram illustrating the star-delta starter; and

Figs. 3a, 3b and 4 illustrate an electromagnetic switch device according to the present invention and a star-delta starter using the electromagnetic switch device, respectively, wherein Fig. 3a is a perspective view illustrating the electromagnetic switch device, Fig. 3b is a cross-sectional view taken along the line A – A of Fig. 3a, and Fig. 4 is an equivalent circuit diagram illustrating the star-delta starter using the electromagnetic switch device according to the present invention.

Best Mode for Carrying Out the Invention

Figs. 3a, 3b and 4 illustrate an electromagnetic switch device according to the present invention and a star-delta starter using the electromagnetic switch device, respectively. Fig. 3a is a perspective view of the electromagnetic switch device, and Fig. 3b is a cross-sectional view taken along the line A - A of Fig. 3a. Fig. 4 is an equivalent circuit diagram of the star-delta starter using the electromagnetic switch device according to the present invention.

As shown in Figs. 3a and 3b, the electromagnetic switch device of the present invention, which is denoted by the reference character C, includes a body 110, and three power terminals 121a, 121b, and 121c arranged at one side of the body 110 and respectively connected to three-phase power lines R, S, and T. The power terminals 121a, 121b, and 121c are insulated from one another. The electromagnetic switch device also includes three main starting terminals 122a, 122b, and 122c arranged at the other side of the body 110 and respectively connected to one-side terminals u, v, and w of a three-phase electric motor M. The main starting terminals 122a, 122b, and 122c are insulated from one another. Three star-delta terminals 123a, 123b, and 123c are arranged at the other side of the body 110 outside the main starting terminals 122a to 122c. The star-delta terminals 123a, 123b, and 123c are connected to the other-side ends Z, X, and Y of the three-phase electric motor M,

respectively. The star-delta terminals 123a, 123b, and 123c are insulated from one another.

An electromagnet 130 for a main circuit and an electromagnet 140 for star-delta connections are disposed at a lower portion of the body 110 in such a fashion that they are laterally aligned with each other while being insulated from each other. The electromagnet 130 includes a fixed core 131 and a coil 132 whereas the electromagnet 140 includes a fixed core 141 and a coil 142.

The electromagnetic switch device also includes a main circuit switching unit 150 arranged above the main circuit-end electromagnet 130 in the interior of the body 110. The main circuit switching unit 150 serves to selectively connect the main starting terminals 122a, 122b, and 122c to respective power terminals 121a, 121b, and 121c in accordance with a magnetization of the main circuit-end electromagnet 130.

The main circuit switching unit 150 includes a main circuit-end moving core 151 and a main circuit-end vertical moving member 152 integrally coupled together and arranged above the main circuit-end electromagnet 130 near the main circuit-end electromagnet 130. The moving core 151 and vertical moving member 152 are adapted to be moved together in accordance with a magnetization of the electromagnet 130. The main circuit switching unit 150 also includes three pairs of main circuit-end fixed contacts 153a, 153b, and 153c arranged at desired

positions within a vertical movement zone of the main circuit-end vertical moving member 152 in such a fashion that the fixed contacts of each fixed contact pair are disposed at opposite sides of the vertical moving member 152, respectively. The fixed contacts 153a, 153b, and 153c arranged at one side of the vertical moving member 152 are connected to the power terminals 121a, 121b, and 121c, respectively, while being insulated from one another. The fixed contacts 153a, 153b, and 153c arranged at the other side of the vertical moving member 152 are connected to the main starting terminals 122a, 122b, and 122c, respectively, while being insulated from one another. Three pairs of moving contacts 154a, 154b, and 154c are mounted to the main circuit-end vertical moving member 152 in such a fashion that the moving contacts of each moving contact pair are disposed at opposite sides of the vertical moving member 152, respectively. The moving contacts 154a, 154b, and 154c arranged at one side of the vertical moving member 152 are insulated from one another. In similar, the moving contacts 154a, 154b, and 154c arranged at the other side of the vertical moving member 152 are insulated from one another. The moving contacts 154a, 154b, and 154c are vertically moved in accordance with a vertical movement of the vertical moving member 152, so that they selectively come into contact with respective associated ones of the fixed contacts 153a, 153b, and 153c, thereby causing the power terminal-end fixed contacts 153a, 153b, and 153c to be

selectively connected to the starting terminal-end fixed contacts 153a, 153b, and 153c.

Return springs 155 are arranged around the moving core 151 between the upper surface of the main circuit-end electromagnet 130 and the lower surface of the main circuit-end vertical moving member 152 in order to provide a return force for returning the vertical moving member 152 to its original position at which the moving contacts 154a, 154b, and 154c are separated from respective associated ones of the fixed contacts 153a, 153b, and 153c. An arc prevention spring 156 is arranged in the main circuit-end vertical moving member 152 in order to always urge the moving contacts 154a, 154b, and 154c toward the fixed contacts 153a, 153b, and 153c, thereby increasing the contact force of the moving contacts 154a, 154b, and 154c when the moving contacts 154a, 154b, and 154c come into contact with the fixed contacts 153a, 153b, and 153c, so as to suppress generation of arc at those contacts.

The electromagnetic switch device further includes a star-delta connection switching unit 160 arranged above the star-delta connection-end electromagnet 140 in the interior of the body 110. The star-delta connection switching unit 160 serves to selectively connect the star-delta terminals 123a, 123b, 123c to one another or to respective main starting terminals 122a, 122b, and 122c in accordance with a magnetization of the star-delta connection-end electromagnet 140.

The star-delta connection switching unit 160 includes a star-delta connection-end moving core 161 and a star-delta connection-end vertical moving member 162 integrally coupled together and arranged above the star-delta connection-end electromagnet 140 near the star-delta connection-end electromagnet 140. The moving core 161 and vertical moving member 162 are adapted to be moved together in accordance with a magnetization of the electromagnet 140. The star-delta connection switching unit 160 also includes three pairs of fixed contacts 163a, 163b, and 163c for star-delta connection arranged at desired positions within a vertical movement zone of the star-delta connection-end vertical moving member 162 in such a fashion that the fixed contacts of each fixed contact pair are disposed at opposite sides of the vertical moving member 162, respectively. The fixed contacts 163a, 163b, and 163c arranged at one side of the vertical moving member 162 are connected to the main starting terminals 122a, 122b, and 122c, respectively, while being insulated from one another. The fixed contacts 163a, 163b, and 163c arranged at the other side of the vertical moving member 162 are connected to the star-delta terminals 123a, 123b, and 123c, respectively, while being insulated from one another. Three pairs of moving contacts 164a, 164b, and 164c for delta connection are mounted to the star-delta connection-end vertical moving member 162 in such a fashion that the moving contacts of each moving contact pair are disposed at

opposite sides of the vertical moving member 162, respectively. The moving contacts 164a, 164b, and 164c arranged at one side of the vertical moving member 162 are insulated from one another. In similar, the moving contacts 164a, 164b, and 164c arranged at the other side of the vertical moving member 162 are insulated from one another. The moving contacts 164a, 164b, and 164c are vertically moved in accordance with a vertical movement of the vertical moving member 162, so that they selectively come into contact with respective associated ones of the fixed contacts 163a, 163b, and 163c, thereby causing the star-delta connection-end fixed contacts 163a, 163b, and 163c to be selectively connected to the starting terminal-end fixed contacts 163a, 163b, and 163c.

Three moving contacts 167a, 167b, and 167c for star connection are also mounted to the star-delta connection-end vertical moving member 162 above the delta connection-end moving contacts 164a, 164b, and 164c near the fixed contacts 163a, 163b, and 163c connected to the star-delta terminals 123a, 123b, and 123c. The star connection-end moving contacts 167a, 167b, and 167c are short-circuited together. The moving contacts 167a, 167b, and 167c are vertically moved in accordance with a vertical movement of the vertical moving member 162, so that they selectively come into contact with respective associated ones of the fixed contacts 163a, 163b, and 163c, thereby causing the fixed contacts 163a, 163b, and 163c to be selectively

connected together. The star connection by the star connection-end moving contacts 167a, 167b, and 167c and the delta connection by the delta connection-end moving contacts 164a, 164b and 164c are achieved in an alternating fashion. For example, the star connection by the star connection-end moving contacts 167a, 167b, and 167c is achieved when the delta connection by the delta connection-end moving contacts 164a, 164b and 164c is released.

Return springs 165 are arranged around the star-delta connection-end moving core 161 between the upper surface of the star-delta connection-end electromagnet 140 and the lower surface of the star-delta connection-end vertical moving member 162 in order to provide a return force for returning the vertical moving member 162 to its original position at which the delta connection-end moving contacts 164a, 164b, and 164c are separated from respective associated ones of the fixed contacts 163a, 163b, and 163c. An arc prevention spring 166 is arranged in the star-delta connection-end vertical moving member 162 in order to always urge the delta connection-end moving contacts 164a, 164b, and 164c and the star connection-end moving contacts 167a, 167b, and 167c toward respective corresponding portions of the fixed contacts 163a, 163b, and 163c, thereby increasing the contact force of the delta connection-end moving contacts 164a, 164b, and 164c or the star connection-end moving contacts 167a, 167b, and 167c when the delta connection-end moving contacts

164a, 164b, and 164c or the star connection-end moving contacts 167a, 167b, and 167c come into contact with the fixed contacts 153a, 153b, and 153c, so as to suppress generation of arc at those contacts.

A timer 170 is arranged beneath the main circuit-end electromagnet 130 and star-delta connection-end electromagnet 140 in the interior of the body 110. The timer 170 serves to count an activation time of the main circuit-end electromagnet 130, thereby determining a point of time when the star-delta connection-end electromagnet 140 is to be activated. Isolating plates 180 are also arranged to isolate adjacent ones of the power terminals 121a, 121b, and 121c, adjacent ones of the main starting terminals 122a, 122b, and 122c, and adjacent ones of the star-delta terminals 123a, 123b, and 123c, respectively.

In the drawings, the reference numeral 191 denotes terminals to which power lines are coupled in order to supply current to the coils 132 and 142. The reference numeral 192 denotes bolts respectively coupled to the terminals 191 in order to provide an easy connection of the power lines to the terminals 191.

The electromagnetic switch device C for star-delta connections having the above mentioned configuration operates in a connection state, as shown in the equivalent circuit diagram of Fig. 4, in such a fashion that it establishes a star connection, when it is desired to start up the electric motor M,

in order to achieve a start-up of the electric motor M using starting current and starting torque reduced to a 1/3 level while switching the connection of the electric motor M to a delta connection after completion of the start-up of the electric motor M. For the best understanding of the present invention, elements of Fig. 4 respectively corresponding to those in Figs. 3a and 3b are denoted by the same reference numerals.

Now, the operation of the electromagnetic switch device C for star-delta connections according to the present invention will be described.

When current flows through the coil 132 of the main circuit-end electromagnet 130, which is constructed by the fixed core 131 and the coil 132, upon starting the three-phase electric motor M, the electromagnet 130 is magnetized by virtue of the current. Simultaneously with the magnetization of the electromagnet 130, the timer 170 begins to count the activation time of the electromagnet 130.

As the electromagnet 130 is activated, it generates a magnetic force greater than the resilience of the return spring 155, so that the moving core 151 and vertical moving member 152 are downwardly moved. At the same time, the main circuit-end moving contacts 154a, 154b, and 154c are downwardly moved, so that they come into contact with the main circuit-end fixed contacts 153a, 153b, and 153c, respectively.

In such an initial state, the star-delta connection-end electromagnet 140 is maintained under a non-magnetization condition, that is, a condition in which no current flows through the coil 142. Accordingly, the star-delta connection-end moving coil 161 and star-delta connection-end vertical moving member 162 are maintained in a state in which they are spaced away from the coil 142 by virtue of the resilience of the return spring 165. In this state, the delta connection-end moving contacts 164a, 164b, and 164c are separated from the associated fixed contacts 163a, 163b, and 163c whereas the star connection-end moving contacts 167a, 167b, and 167c are in contact with the associated fixed contacts 163a, 163b, and 163c, that is, in a state short-circuited to the associated fixed contacts 163a, 163b, and 163c.

Accordingly, the three-phase electric motor M is in a star connection state, so that it is started up by electric power supplied via the three-phase power lines R, S, and T respectively connected to the power terminal 121a, 121b, and 121c.

After a predetermined period of time elapses, the timer 170 operates to allow current to flow through the coil 142 of the star-delta connection-end electromagnet 140. By virtue of the current, the star-delta connection-end electromagnet 140 is magnetized.

As the electromagnet 130 is activated, it generates a

magnetic force greater than the resilience of the return spring 165, so that the moving core 161 and vertical moving member 162 are downwardly moved.

At the same time, the star connection-end moving contacts 167a, 167b, and 167c are downwardly moved, so that they are separated from the associated fixed contacts 163a, 163b, and 163c, respectively. Also, the delta connection-end moving contacts 164a, 164b, and 164c are downwardly moved, so that they come into contact with the associated fixed contacts 163a, 163b, and 163c, respectively.

As a result, the main starting terminals 122a, 122b, and 122c are connected with the star-delta terminals 123a, 123b, and 123c, respectively, so that the three-phase electric motor M is switched to a delta connection state in which it is driven at a full speed.

Industrial Applicability

As apparent from the above description, the present invention provides an electromagnetic switch device for star-delta connections which includes two electromagnets arranged in its body and two switching units operating in accordance with respective magnetization states of the electromagnets in order to selectively establish a star connection or a delta connection for a three-phase electric motor. The electromagnetic switch device of the present invention can reduce installation costs

and an occupation space when it is applied to a star-delta starter. In addition, there is no unnecessary wiring. Accordingly, it is possible to reduce erroneous connections and erroneous operations.

Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

WHAT IS CLAIMED IS:

1. An electromagnetic switch device for star-delta connections comprising:

a body;

three power terminals arranged at one side of the body and respectively connected to three-phase power lines, the power terminals being insulated from one another;

three main starting terminals arranged at the other side of the body and respectively connected to one-side terminals of a three-phase electric motor, the main starting terminals being insulated from one another;

three star-delta terminals arranged at the other side of the body outside the main starting terminals and connected to the other-side ends of the three-phase electric motor, respectively, the star-delta terminals being insulated from one another;

an electromagnet for a main circuit and an electromagnet for star-delta connections disposed at a lower portion of the body in such a fashion that they are laterally aligned with each other while being insulated from each other, each of the electromagnets including a fixed core and a coil wound around the fixed core;

a main circuit switching unit arranged near the main circuit-end electromagnet in the interior of the body, the main

circuit switching unit serving to selectively connect each of the main starting terminals to an associated one of the power terminals in accordance with a magnetization of the main circuit-end electromagnet; and

a star-delta connection switching unit arranged near the star-delta connection-end electromagnet in the interior of the body, the star-delta connection switching unit serving to selectively connect the star-delta terminals to one another or to the main starting terminals, respectively, in accordance with a magnetization of the star-delta connection-end electromagnet.

2. The electromagnetic switch device in accordance with claim 1, further comprising:

a timer arranged in the interior of the body and adapted to count an activation time of the main circuit-end electromagnet, thereby determining a point of time when the star-delta connection-end electromagnet is to be activated.

3. The electromagnetic switch device in accordance with claim 1, further comprising:

isolating plates arranged between adjacent ones of the power terminals, between adjacent ones of the main starting terminals, and between adjacent ones of the star-delta terminals to isolate the adjacent power terminals, the adjacent main starting terminals, and the adjacent star-delta terminals,

respectively.

4. The electromagnetic switch device in accordance with claim 1, wherein the main circuit switching unit comprises:

a moving core vertically movable in accordance with a magnetization of the main circuit-end electromagnet;

a vertical moving member integrally coupled to the moving core in such a fashion that it is moved along with the moving core;

three pairs of fixed contacts arranged at desired positions within a vertical movement zone of the vertical moving member in such a fashion that the fixed contacts included in each of the fixed contact pairs are disposed at opposite sides of the vertical moving member, respectively, the fixed contacts arranged at one side of the vertical moving member being connected to the power terminals, respectively, while being insulated from one another, and the fixed contacts arranged at the other side of the vertical moving member being connected to the main starting terminals, respectively, while being insulated from one another; and

three pairs of moving contacts mounted to the vertical moving member in such a fashion that the moving contacts included in each of the moving contact pairs are disposed at opposite sides of the vertical moving member, respectively, the moving contacts arranged at one side of the vertical moving

member being insulated from one another, the moving contacts arranged at the other side of the vertical moving member being insulated from one another, and the moving contacts being vertically moved in accordance with a vertical movement of the vertical moving member, so that they selectively come into contact with respective associated ones of the fixed contacts, thereby causing the power terminal-end fixed contacts to be selectively connected to the starting terminal-end fixed contacts.

5. The electromagnetic switch device in accordance with claim 1, wherein the star-delta connection switching unit comprises:

a moving core vertically movable in accordance with a magnetization of the star-delta connection-end electromagnet;

a vertical moving member integrally coupled to the moving core in such a fashion that it is moved along with the moving core;

three pairs of fixed contacts for star-delta connection arranged at desired positions within a vertical movement zone of the vertical moving member in such a fashion that the fixed contacts included in each of the fixed contact pairs are disposed at opposite sides of the vertical moving member, respectively, the fixed contacts arranged at one side of the vertical moving member being connected to the main starting

terminals, respectively, while being insulated from one another, and the fixed contacts arranged at the other side of the vertical moving member being connected to the star-delta terminals, respectively, while being insulated from one another;

three pairs of moving contacts for delta connection mounted to the vertical moving member in such a fashion that the moving contacts included in each of the moving contact pairs are disposed at opposite sides of the vertical moving member, respectively, the moving contacts arranged at one side of the vertical moving member being insulated from one another, the moving contacts arranged at the other side of the vertical moving member being insulated from one another, and the moving contacts being vertically moved in accordance with a vertical movement of the vertical moving member, so that they selectively come into contact with respective associated ones of the fixed contacts, thereby causing the star-delta connection-end fixed contacts to be selectively connected to the starting terminal-end fixed contacts so as to achieve a delta connection; and

three moving contacts for star connection mounted to the vertical moving member at a position vertically shifted from the delta connection-end moving contacts near the star-delta connection-end fixed contacts, the star connection-end moving contacts being short-circuited together, and the star connection-end moving contacts being vertically moved in accordance with a vertical movement of the vertical moving

member, so that they selectively come into contact with respective associated ones of the fixed contacts, thereby causing the fixed contacts to be selectively connected together so as to achieve a star connection, the star connection by the star connection-end moving contacts being achieved when the delta connection by the delta connection-end moving contacts is released.

6. The electromagnetic switch device in accordance with claim 4 or 5, further comprising:

a return springs adapted to provide a return force for returning the vertical moving member to an original position thereof at which the moving contacts are separated from respective associated ones of the fixed contacts.

7. The electromagnetic switch device in accordance with claim 4 or 5, further comprising:

an arc prevention spring arranged in the vertical moving member and adapted to always urge the moving contacts toward the fixed contacts, thereby increasing the contact force of the moving contacts when the moving contacts come into contact with the fixed contacts, so as to suppress generation of arc at regions where the moving contacts come into contact with the fixed contacts, respectively.

FIG. 1a

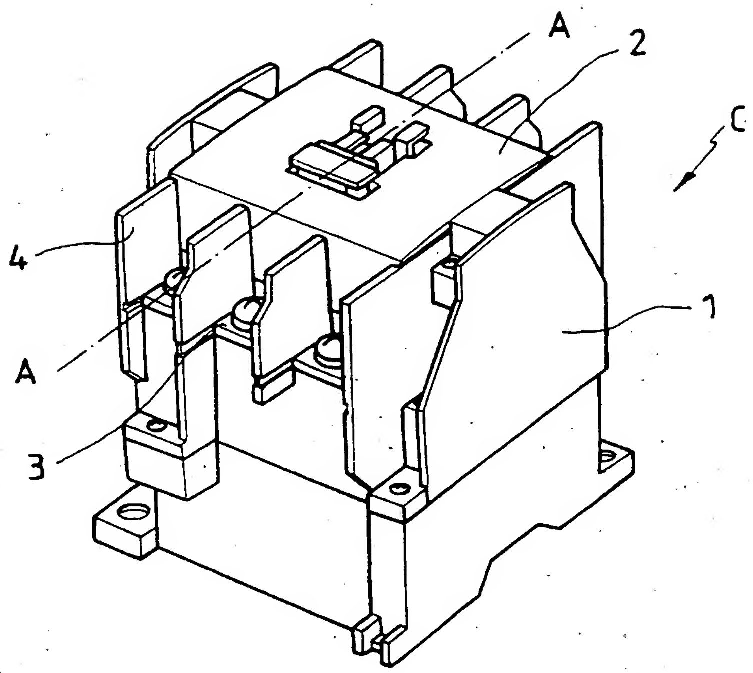


FIG. 1b

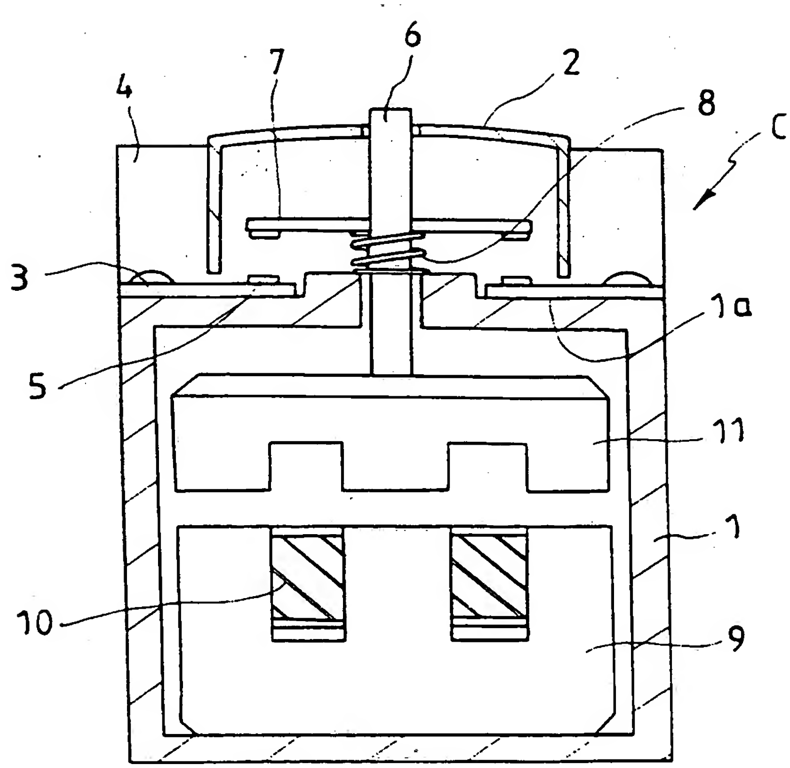


FIG.2

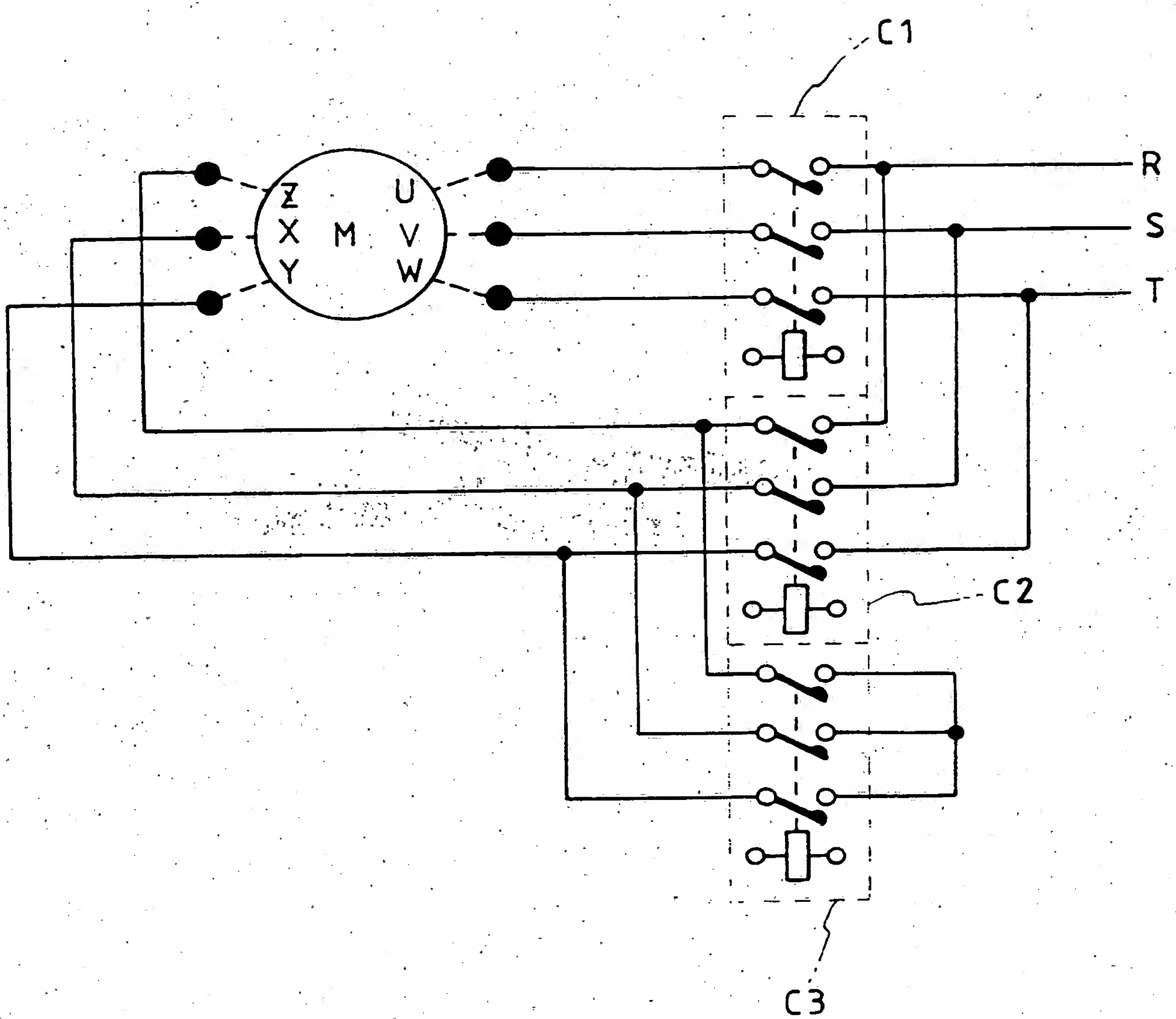


FIG.3a

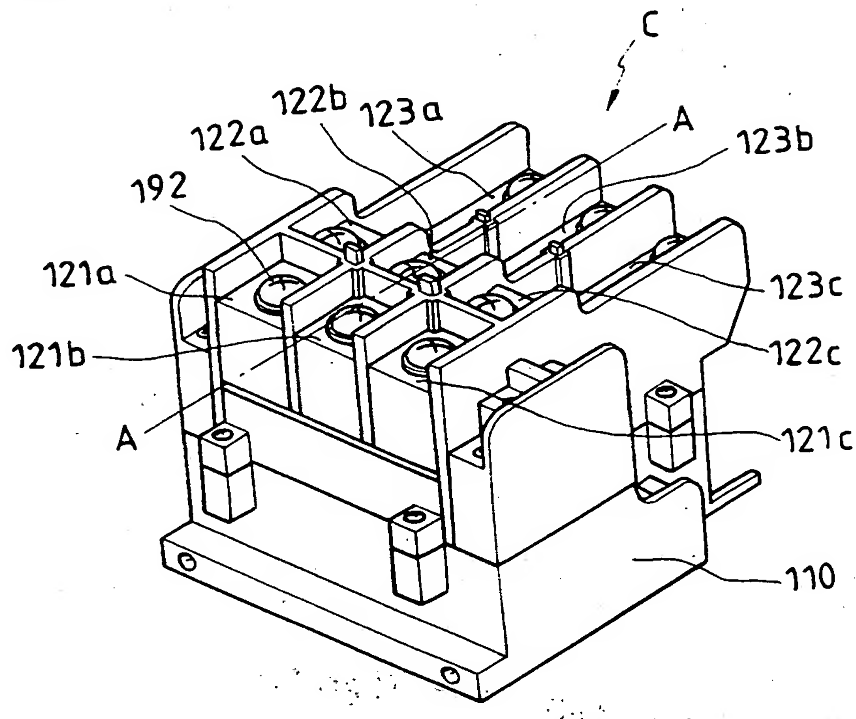
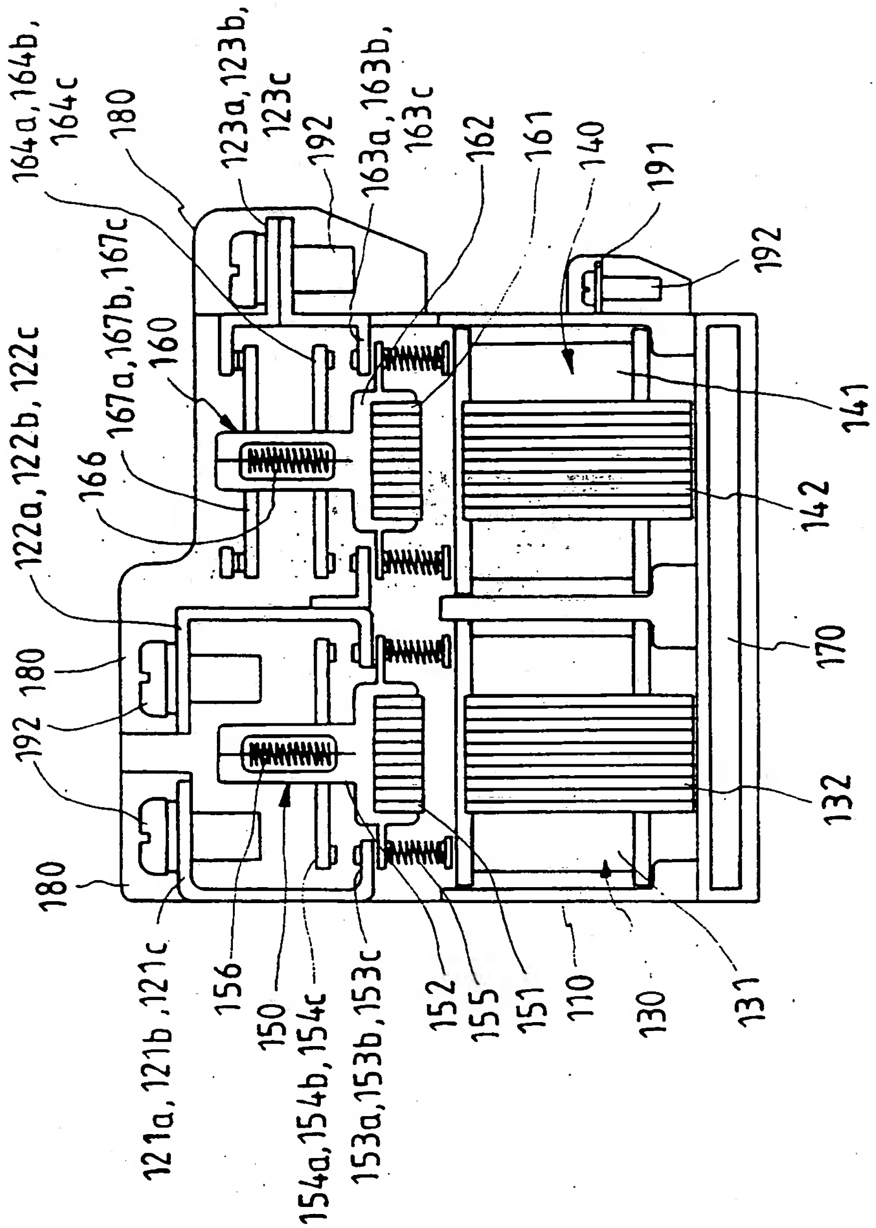


FIG.3b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123c
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153a,153b,153c
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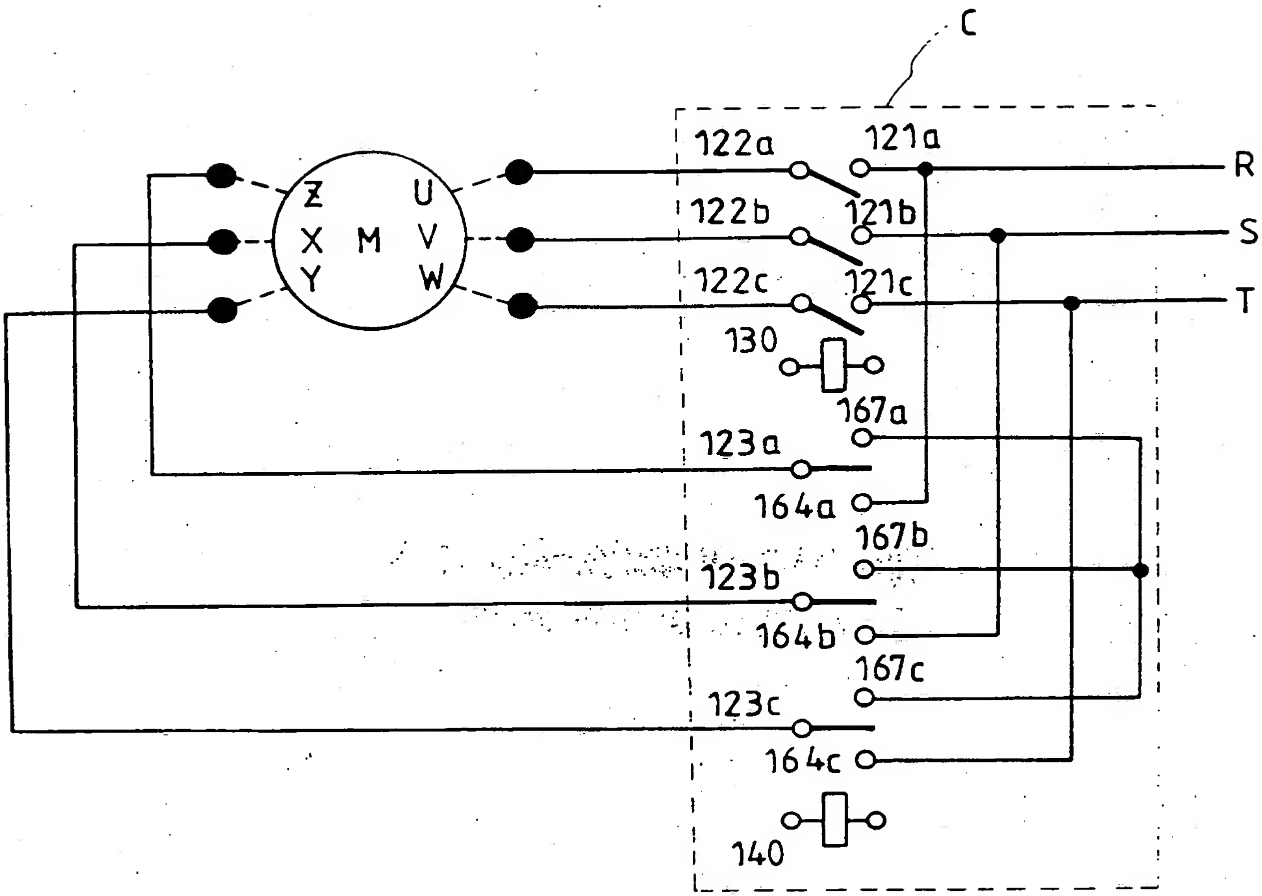
160

FIG.4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S
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T
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123a
164a
167b
123b
164b
167c
123c
164c
140

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR00/00039

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H01H 50/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimun documentation searched (classification system followed by classification symbols)

IPC7 H01H50/00, H02P01/32

Documentation searched other than minimun documentation to the extent that such documents are included in the fileds searched

Korean Patents and applications for inventions since 1975
Korean Utillity models and applications for Utility models since 1975
Jappanese Utillity models and applications for Utility models since 1975

Electronic data base consulted during the intertnational search (name of data base and, where practicable, search trerms used)
WPI, PAJ, IEEE/IEE electronic Library (since 1988) "STAR, DELTA", "STARTER", "RELAY"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	KR 1998-014546 U (JONG, UI GYUN) 5 JUNE 1998 (05.06.1998) The whole document	1 2-7
Y	KR 1992-013872 A (KOLON CO., LTD) 29 JULY 1992 (29.07. 1992) The whole document	1-7
Y	KR 1995-025850 U (YU, JOMG SANG) 18 SEPTEMBER 1995 (18.09.1995). The whole document	1-7
Y	JP 01-286785 A (NEC CORP) 17 NOVEMBER 1989 (17. 11. 1989) The whole document	1-7
A	JP 10-271863 A (ISHIKAWAJIMA SHIBAURA MACH CO LTD) 9 OCTOBER 1998 (09.10.1998) The whole document	1-7
A	KR 1989-07818 U (DAEWOO HEAVY INDUSTRY CO. LTD) 17 MAY 1989 (17.05.1989) The whole document	1-7
A	KR 1987-015519 U (LG CABLE CO. LTD) 26 OCTOBER 1987 (26.10.1987) The whole document	1-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevence
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevence: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevence: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 MAY 2000 (31.05.2000)	05 JUNE 2000 (05.06.2000)
Name and mailing address of the ISA/KR Korean Industrial Property Office Government Complex-Taejon, Dunsan-dong, So-ku, Taejon Metropolitan City 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer PARK, Jung Sik Telephone No. 82-42-481-5779

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PATENT COOPERATION TREATY

PCT

REC'D 10 SEP 2001
WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Artcle 36 and Rule 70)

Applicant's or agent's file reference 00-PCT-001	**FOR FURTHER ACTION**	SeeNotificationofTransmittalofInternationalPreliminary Examination Report (Form PCT/IPEA/416)
International application No. **PCT/KR00/00039**	International filing date *(day/month/year)* 20 JANUARY 2000 (20.01.2000)	Priority date *(day/month/year)* 11 MAY 1999 (11.05.1999)

International Patent Classification (IPC) or national classification and IPC

IPC7 H01H 50/00

Applicant

INTERVENTION CO., LTD

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 38 sheets.

3. This report contains indications relating to the following items:

   - I [X] Basis of the report
   - II [ ] Priority
   - III [ ] Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV [ ] Lack of unity of invention
   - V [X] Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI [ ] Certain documents cited
   - VII [ ] Certain defects in the international application
   - VIII [ ] Certain observations on the international application

Date of submission of the demamd	Date of completion of this report
20 JANUARY 2000 (20.01.2000)	29 AUGUST 2001 (29.08.2001)
Name and mailing address of the IPEA/KR Korean Intellectual Property Office Government Complex-Daejeon, Dunsan-dong, Seo-gu, Daejeon Metropolitan City 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer BAK, Junyung Telephone No. 82-42-481-5729

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International aplication No.
PCT/KR00/00039

I. Basis of the report

1: With regard to the elements of the international application:*

- [ ] the international application as originally filed
- [X] the description:
  pages ______ , as originally filed
  pages ______ , filed with the demand
  pages 1-22 , filed with the letter of 20/03/2001 (20/07/2001)
- [X] the claims:
  pages ______ , as originally filed
  pages ______ , as amended (together with any statment) under Article 19
  pages ______ , filed with the demand
  pages 23-26 , filed with the letter of 20/03/2001 (20/07/2001)
- [X] the drawings:
  pages ______ , as originally filed
  pages ______ , filed with the demand
  pages 1/11-11/11 , filed with the letter of 20/03/2001(20/07/2001)
- [ ] the sequence listing part of the description:
  pages ______ , as originally filed
  pages ______ , filed with the demand
  pages ______ , filed with the letter of ______

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language English which is

- [ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- [X] the language of publication of the international application(under Rule 48.3(b)).
- [ ] the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/ or 55.3).

3. With regard to any **nucleotide** and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- [ ] contained inthe international application in written form.
- [ ] filed together with the international application in computer readable form.
- [ ] furnished subsequently to this Authority in written form.
- [ ] furnished subsequently to this Authority in computer readable form
- [ ] The statement that the subsequently furnished written sequence listing does not go beyond the disc losure in the international applicationas as filed has been furinshed.
- [ ] The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. [X] The amendments have resulted in the cancellation of:
   - [ ] the description, pages ______
   - [X] the claims, Nos. 2-4, 7
   - [ ] the drawings, sheet ______

5. [ ] This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box(Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed." and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.*

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

ational aplication No.
PCT/KR00/00039

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1, 5, 6	YES
	Claims		NO
Inventive step (IS)	Claims	1, 5, 6	YES
	Claims		NO
Industrial applicability (IA)	Claims	1, 5, 6	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

This statement is based on the amended claims 1, 5, 6 filed on March 20, 2001 with the letter of July 20, 2001.

The claimed invention relates to an electromagnetic switch device designed to be used for a star-delta starter adapted to start up a three-phase electric motor. The electromagnetic switch device is configured to switch on and off a main power source by electric switching operations conducted by a main circuit-end electromagnet and a main circuit-end vertical moving member. It is also configured to selectively enable a star connection or a delta connection in accordance with the switching operation of a star-delta connection-end electromagnet and a star-delta connection-end vertical moving member.

None of the documents in the International Search Report (ISR), taken alone or in combination, discloses the special combination of features defined in the invention. Furthermore, in the ISR documents there are no suggestions leading a person skilled in the art towards the invention defined by amended claims 1, 5, 6. Therefore. the invention is novel, involves an inventive step, and has industrial applicability.

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ELECTROMAGNETIC SWITCH DEVICE

Technical Field

The present invention relates to an electromagnetic switch device for star-delta connections, and more particularly to an electromagnetic switch device designed to be used for a star-delta starter adapted to start up a three-phase electric motor in order to allow the motor to be driven at its full speed within a short period of time.

Background Art

As well known, star (Y)-delta (Δ) starters, which are used to start up an electric motor, serve to establish a star connection for the electric motor upon the start-up of the electric motor, thereby reducing starting current and starting torque required in the start-up of the electric motor to a 1/3 level, while switching the connection for the electric motor into a delta connection after completion of the start-up of the electric motor so that the electric motor is driven in the delta connection state. Such star-delta starters are widely used in a variety of industrial fields in order to protect electric motors and peripheral devices thereof from overload.

Star-delta starters are classified into a contact type using an electromagnetic switch device adapted to switch electric contacts by use of electromagnets, and a non-contact type using a semiconductor switch device. The type using an electromagnetic switch device is more widely used.

FIGS. 1a, 1b and 2 illustrate a conventional electromagnetic switch device and a star-delta starter using the electromagnetic switch device, respectively. FIG. 1a is a perspective view illustrating the

electromagnetic switch device, and FIG. 1b is a cross-sectional view taken along the line a - a of FIG. 1a. FIG. 2 is an equivalent circuit diagram illustrating the star-delta starter.

As shown in FIGS. 1a and 1b, the conventional electromagnetic switch device, which is denoted by the reference character C, includes a body 1, and a cover 2 detachably attached to an upper surface 1a of the body 1. Three pairs of terminals 3 are disposed on the upper surface 1a of the body 1 in such a fashion that the terminals of each terminal pair are arranged at opposite sides of the body 1, respectively, while being insulated from one another. Electric power lines not shown are connected to the terminals 3, respectively. Isolating plates 4 are arranged at opposite sides of the cover 2 to isolate adjacent ones of the terminals 3.

Three pairs of fixed contacts 5 are also arranged on the upper surface 1a of the body 1. Each fixed contact 5 is arranged at an end of an associated one of the terminals 3 extending toward a central portion of the body 1. The fixed contacts 5 are insulated from one another. A vertical moving member 6 is arranged at the central portion of the body 1 in such a fashion that it is upwardly and downwardly movable. Three pairs of moving contacts 7 insulated from one another are mounted to the vertical moving member 6 at opposite sides of the vertical moving member 6 in such a fashion that each of the moving contacts 7 selectively comes into contact with an associated one of the fixed contacts 5 so that it is short-circuited or opened with respect to the associated fixed contact 5. A compression coil spring 8 is arranged around the vertical moving member 6 between the upper surface 1a of the body 1 and the moving contacts 7 in such a fashion that it always urges the vertical moving member 6 upwardly.

A fixed core 9 is arranged at a lower portion of the body 1. A coil 10 is wound around the fixed core 9 in order to form an electromagnet. Above the fixed core 9, a moving core 11 is arranged in such a fashion that it moves vertically along with the vertical moving member 6 in accordance with a magnetization of the electromagnet.

The conventional star-delta starter using electromagnetic switch devices having the above mentioned configuration includes an electromagnetic switch device C1 for a main circuit, an electromagnetic switch device C2 for a star circuit, and an electromagnetic switch device C3 for a delta connection, which are connected together as shown in the equivalent circuit diagram of FIG. 2 and activated by a timer (not shown) separately installed.

When current flows through the coil 10 of the electromagnetic switch device C2 for the star circuit upon starting a three-phase electric motor M, the electromagnet formed by the fixed core 9 and coil 10 is magnetized by virtue of the current.

Accordingly, the electromagnet generates a magnetic force greater than the resilience of the spring 8, so that the vertical moving member 6 and moving core 11 are downwardly moved. As a result, the moving contacts 7, which also move downwardly, come into contact with the fixed contacts 5, respectively.

When the electromagnetic switch device C1 for the main circuit is activated in accordance with the same procedure as mentioned above, a star connection is established for the three-phase electric motor M, so that the three-phase electric motor M is started up using starting current and starting torque reduced to a 1/3 level. At the same time, the timer (not shown) separately installed begins to operate in order to count

the drive time of the three-phase electric motor M.

After a predetermined period of time elapses, the current flowing through the coil 10 of the electromagnetic switch device C2 for the star connection is cut off by an operation of the timer. At the same time, current flows through the coil 10 of the electromagnetic switch device C3 for the delta connection.

In this state, the magnetic force of the electromagnet formed by the fixed core 9 and coil 10 of the electromagnetic switch device C2 for the star connection disappears. As a result, the vertical moving member 6 is upwardly moved along with the moving core 11 and moving contacts 7 by virtue of the resilience of the spring 8, thereby causing the moving contacts 7 to be separated from the fixed contacts 5.

Meanwhile, the electromagnet formed by the fixed core 9 and coil 10 of the electromagnetic switch device C3 for the delta connection is magnetized by virtue of the current flowing through the coil 10. As a result, the moving contacts 7 are downwardly moved, so that they come into contact with the fixed contacts 5, respectively.

Accordingly, the electromagnetic switch device C3 for the delta connection is short-circuited to electric power lines at its one-side terminals 3. As a result, the three-phase electric motor M is switched to the star connection state to a delta connection state, so that it is driven at a full speed.

In the star-delta starter having the above mentioned configuration, each of its electromagnetic switch devices is used only for a single purpose, that is, a star connection or a delta connection. For this reason, the conventional star-delta starter cannot implement a desired system unless at least three

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electromagnetic switch devices including the electromagnetic switch C1 for the main circuit, the electromagnetic switch C2 for the star connection, and the electromagnetic switch C3 for the delta connection, as shown in FIGS. 3a and 3b.

FIG. 3a is a view illustrating a practical connection of a three-phase motor provided with a convention electromagnetic switch device. FIG. 3b is an equivalent circuit diagram of the conventional electromagnetic switch device shown in FIG. 3a.

In the case of a two-contact type electromagnetic switch device, there is always a possibility of danger because a main power source is directly connected to a motor. For this reason, 3-contact type electromagnetic switch devices are mainly used in motors of a large capacity. For instance, electromagnetic switch devices having a configuration described in detail in conjunction with FIGS. 1 and 2 have been used in diverse fields. Practically, three electromagnetic switch devices C, that is, the electromagnetic switch device C1 for the main circuit, the electromagnetic switch device C2 for the star connection, and the electromagnetic switch device C3 for the delta connection, are used in a state assembled together under the condition in which the timer T is additionally installed, as shown in FIGS. 3a and 3b. For this reason, there is a high rate of erroneous line connections. Furthermore, there are disadvantages such as high manufacturing and installing costs and a large occupation space.

The conventional star-delta starter also involves a complex wiring for the connection between the electric motor M and each electromagnetic switch device C. Such a complex wiring may result in a possibility of erroneous connections. As a result, the motor M may be frequently damaged, thereby resulting in a possibility of a severe

accident.

Disclosure of the Invention

Therefore, an object of the invention is to solve the above mentioned problems involved in the prior art, and to provide an electromagnetic switch device for star-delta connections which includes two electromagnets arranged in its body and two switching units operating in accordance with respective magnetization states of the electromagnets in order to selectively establish a star connection or a delta connection for a three-phase electric motor, so that it can reduce installation costs and an occupation space when it is applied to a star-delta starter while using no unnecessary wiring, thereby reducing erroneous connections and erroneous operations.

In accordance with the present invention, this object is accomplished by providing An electromagnetic switch device for star-delta connections comprising: a body; first through third power terminals arranged at one side portion of the body on an upper surface of the body and respectively connected to three-phase power lines; first through third main terminals arranged at an intermediate portion of the body on the upper surface of the body and respectively connected to one-side terminals of a three-phase electric motor; first through third star-delta terminals arranged at the other side portion of the body on the upper surface of the body and connected to the other-side terminals of the three-phase electric motor, respectively; a star connection plate set on the upper surface of the body and adapted to connect the first through third star-delta terminals to a star circuit; first through third contacts set beneath the star connection plate and adapted to connect the first through third star-delta terminals to a delta circuit; a timer assembled to the body at a bottom of

the body while being integral with the body, the timer serving to control a start-up time for the three-phase motor ; an electromagnet for a main circuit and an electromagnet for star-delta connections each including a fixed core and a coil assembled in the interior of the body, each of the electromagnets being selectively magnetized in accordance with a cooperation of the fixed core and coil thereof; a main circuit switching unit for selectively connecting the first through third power terminals with the first through third main terminals, respectively, in accordance with the magnetization of the main circuit-end electromagnet; and a star-delta connection switching unit for connecting the star connection plate to the first through third star-delta terminals in accordance with the magnetization of the main circuit-end electromagnet under a condition in which the first through third power terminals are connected with the first through third main terminals, thereby allowing the three-phase motor to be start up in a star connection state, the star-delta connection switching unit also serving to connect the first through third delta connection contacts to the first through third star-delta terminals when the star-delta connection-end electromagnet is magnetized in accordance with an operation of the timer after the start-up of the three-phase motor, thereby causing the three-phase motor to be driven in a delta connection state; whereby the electromagnetic switch device has a configuration capable of enabling a selective connection of the three-phase electric motor to the star circuit or the delta circuit while simplifying a wiring for the connection.

Brief Description of the Drawings

The above objects, and other features and advantages of the present invention will become more

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apparent after a reading of the following detailed description when taken in conjunction with the drawings, in which:

FIGS. 1a, 1b and 2 illustrate a conventional electromagnetic switch device and a star-delta starter using the electromagnetic switch device, respectively, wherein FIG. 1a is a perspective view illustrating the electromagnetic switch device, FIG. 1b is a cross-sectional view taken along the line a - a of FIG. 1a, and FIG. 2 is an equivalent circuit diagram illustrating the star-delta starter; and

FIG. 3a is a view illustrating a practical connection of a three-phase motor provided with a convention electromagnetic switch device;

FIG. 3b is an equivalent circuit diagram of the conventional electromagnetic switch device shown in FIG. 3a;

FIG. 4 is a perspective view illustrating an electromagnetic switch device according to the present invention;

FIG. 5 is an equivalent circuit diagram of a star-delta starter using the electromagnetic switch device according to the present invention;

FIG. 6a is a cross-sectional view taken along the line A - A of FIG. 4;

FIG. 6b is a cross-sectional view taken along the line B - B of FIG. 4;

FIG. 6c is a cross-sectional view taken along the line C - C of FIG. 4;

FIG. 7a is a perspective view illustrating a main circuit switching unit applied to the electromagnetic switch device of the present invention;

FIG. 7b is a perspective view illustrating a star-delta connection switching unit applied to the electromagnetic switch device according to the present

invention;

FIG. 8a is a view illustrating the practical connection state of a three-phase motor to which the electromagnetic switch device of the present invention is applied; and

FIG. 8b is an equivalent circuit diagram illustrating the electromagnetic switch device of the present invention shown in FIG. 8a.

Best Mode for Carrying Out the Invention

FIG. 4 is a perspective view illustrating an electromagnetic switch device according to the present invention. FIG. 5 is an equivalent circuit diagram of a star-delta starter using the electromagnetic switch device according to the present invention.

As shown in FIGS. 4 and 5, the electromagnetic switch device of the present invention, which is denoted by the reference character C, is designed to achieve a stable three-contact type connection, in order to eliminate problems resulting from an instable two-contact type connection implemented in conventional cases. The electromagnetic switch device according to the present invention has a configuration in which a timer 170 is contained in a body 110, along with a system for switching on and off a main power source, and switching systems for a star connection and a delta connection, as shown in FIGS. 4 and 5.

FIG. 6a is a cross-sectional view taken along the line A - A of FIG. 4. FIG. 6b is a cross-sectional view taken along the line B - B of FIG. 4. FIG. 6c is a cross-sectional view taken along the line C - C of FIG. 4.

As mentioned above, the electromagnetic switch device according to the present invention has a configuration in which the timer 170 is contained in the

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body 110 while being assembled to the body 110. Also, the electromagnetic switch device is configured to switch on and off the main power source by electronic switching operations conducted by an electromagnetic 130 for a main circuit and a vertical moving member 152 for the main circuit. The electromagnetic switch device is also configured to selectively enable a star connection or a delta connection in accordance with the switching operation of a single star-delta switch including an electromagnet 140 for the star-delta connection and a vertical moving member 162 for the star-delta connection. Thus, the electromagnetic switch device according to the present invention has a configuration made by composing, in the form of a single product, an electromagnetic switch device C1 for a main circuit, an electromagnetic switch device C2 for a star connection, and an electromagnetic switch device C3 for a delta connection, which have conventional configurations, respectively.

As apparent from FIGS. 8a and 8b illustrating the practical connection state of a three-phase motor, the electromagnetic switch device C, which has the form of a single product capable of achieving respective switching functions for the main circuit, star connection and delta connection, can simplify the wiring required for desired connections, as compared to the conventional case of FIGS. 3a and 3b. Moreover, the electromagnetic switch device C of the present invention exhibits superior assemblability, productivity, and stability, taking into consideration the fact that it is designed to stably achieve respective functions corresponding to those of three electromagnetic switch devices C1, C2, and C3 in the conventional case, using a single product.

FIG. 8a is a view illustrating the practical connection state of a three-phase motor to which the

electromagnetic switch device C of the present invention is applied. FIG. 8b is an equivalent circuit diagram illustrating the electromagnetic switch device C of the present invention shown in FIG. 8a.

In accordance with a preferred embodiment of the present invention illustrated in FIGS. 4 and 5, the electromagnetic switch device C includes a body 110, and first through third power terminals 121a, 121b, and 121c arranged at one side portion of the body 110 on the upper surface of the body 110 and respectively connected to three-phase power lines R, S, and T. The power terminals 121a, 121b, and 121c are insulated from one another. The electromagnetic switch device C also includes first through third main terminals 122a, 122b, and 122c arranged at an intermediate portion of the body 110 on the upper surface of the body 110 and respectively connected to one-side terminals u, v, and w of a three-phase electric motor M. The main terminals 122a, 122b, and 122c are insulated from one another. First through third star-delta terminals 123a, 123b, and 123c are arranged at the other side portion of the body 110 on the upper surface of the body 110. The star-delta terminals 123a, 123b, and 123c are connected to the other-side terminals Z, X, and Y of the three-phase electric motor M, respectively. The star-delta terminals 123a, 123b, and 123c are insulated from one another.

The electromagnetic switch device C further includes a star connection plate 124 arranged at the upper surface of the body 110 and adapted to connect the first through third star-delta terminals 123a, 123b, and 123c to a star circuit. First through third contacts 125a, 125b, and 125c are set beneath the star connection plate 124 in order to connect the first through third star-delta terminals 123a, 123b, 123c to a delta circuit.

An electromagnet 130 for a main circuit and an electromagnet 140 for star-delta connections are disposed at a lower portion of the body 110 in such a fashion that they are laterally aligned with each other while being insulated from each other. The electromagnet 130 includes a fixed core 131 and a coil 132 whereas the electromagnet 140 includes a fixed core 141 and a coil 142. The electromagnetic switch device also includes a main circuit switching unit 150 arranged above the main circuit-end electromagnet 130 in the interior of the body 110 and adapted to switch on and off the main power source. A star-delta connection switching unit 160 is set above the star-delta connection-end electromagnet 140 in order to allow the three-phase motor M to be started up in a star connection state, and then to be driven in a delta connection state.

The main circuit switching unit 150 serves to selectively connect the first through third main terminals 122a, 122b, and 122c to respective power terminals 121a, 121b, and 121c in accordance with a magnetization of the main circuit-end electromagnet 130.

FIG. 7a is a perspective view illustrating a main circuit switching unit applied to the electromagnetic switch device of the present invention.

As shown in FIG. 7a, the main circuit switching unit 150 includes a main circuit-end moving core 151 and a main circuit-end vertical moving member 152 integrally coupled together and arranged above the main circuit-end electromagnet 130. The main circuit switching unit 150 also includes three main circuit-end moving members 154a, 154b, and 154c respectively adapted to connect the first through third power terminals 121a, 121b, and 121c to the first through third main terminals 122a, 122b, and 122c in accordance with downward movements thereof conducted along with the main circuit-end moving member

152 when the main circuit-end electromagnet 130 is magnetized.

The main circuit switching unit 150 also includes main circuit-end compression coil springs 155 arranged around the moving core 151 between the upper surface of the main circuit-end electromagnet 130 and the lower surface of the main circuit-end vertical moving member 152 in order to provide a return force for returning the vertical moving member 152 to its upper position. The main circuit-end compression coil springs 155 are arranged in pair in such a fashion that those of each pair are disposed at opposite sides of the main circuit-end electromagnet 130.

The main circuit-end compression coil springs 155 serve to always urge the main circuit-end vertical moving member 152 to move upwardly in a normal state. The main circuit-end compression coil springs 155 have an elastic coefficient lower than the magnetic force of the main circuit-end electromagnet 130 in order to allow the main circuit-end vertical moving member 152 to move downwardly against the urging force of the main circuit-end compression coil springs 155 when the main circuit-end electromagnet 130 is magnetized, thereby causing the first through third power terminals 121a, 121b, and 121c to the first through third main terminals 122a, 122b, and 122c, respectively.

Preferably, the main circuit switching unit 150 further includes main circuit-end damping springs 156 for damping impact generated when the first through third main circuit-end moving members 154a, 154b, 154c abruptly contact associated fixed contacts as the main circuit-end vertical moving member 152 moves downwardly by virtue of the magnetic force of the main circuit-end electromagnet 130, respectively. Three main circuit-end damping springs 156 are provided as one set.

Since the magnetic force of the magnetized main circuit-end electromagnet 130 is higher than the elastic coefficient of the main circuit-end compression coil springs 155, the main circuit-end vertical moving member 152 may be abruptly lowered when the main circuit-end electromagnet 130 is magnetized, thereby generating impact or noise. To this end, the main circuit-end damping springs 156 are provided in order to damp impact or noise possibly generated when the first through third main circuit-end moving members 154a, 154b, and 154c connect the first through third power terminals 121a, 121b, and 121c with the first through third main terminals 122a, 122b, and 122c.

The star-delta connection switching unit 160 serves to switch the three-phase motor M between the star connection and the delta connection as it moves vertically in accordance with a magnetization of the star-delta connection-end electromagnet 140.

In detail, the star-delta connection switching unit 160 connects the star connection plate 124 to associated fixed contacts in accordance with the magnetization of the main circuit-end electromagnet 130 under the condition in which the first through third power terminals 121a, 121b, and 121c are connected to the first through third main terminals 122a, 122b, and 122c, thereby allowing the three-phase motor M to be start up in a star connection state. When the star-delta connection-end electromagnet 140 is subsequently magnetized in accordance with an operation of the timer 170, the star-delta connection switching unit 160 connects the first through third delta connection contacts 125a, 125b, and 125c to the first through third star-delta terminals 123a, 123b, and 123c, thereby causing the three-phase motor M to be driven in a delta connection state.

FIG. 7b is a perspective view illustrating the star-delta connection switching unit applied to the electromagnetic switch device according to the present invention.

In accordance with a preferred embodiment of the present invention illustrated in FIG. 7b, the star-delta connection switching unit 160 includes a star-delta connection-end moving core 161 and a star-delta connection-end vertical moving member 162 integrally coupled together and arranged above the star-delta connection-end electromagnet 140. The moving core 161 and vertical moving member 162 are adapted to be moved together in accordance with a magnetization of the electromagnet 140. The star-delta connection switching unit 160 also includes first through third star connection-end moving members 167a, 167b, and 167c adapted to move upwardly along with the star-delta connection-end vertical moving member 162 in accordance with a magnetization of the main circuit-end electromagnet 130 under the condition in which the first through third main terminals 122a, 122b, and 122c are connected to the first through third power thermals 121a, 121b, and 121c, so that they are connected to the first through third star-delta terminals 123a, 123b, and 123c while being connected to the star connection plate 124, thereby allowing the three-phase motor M to be started up in a star connection state. The star-delta connection switching unit 160 further includes first through third delta connection-end moving members 164a, 164b, and 164c adapted to move downwardly along with the star-delta connection-end vertical moving member 162 when the star-delta connection-end electromagnet 140 is magnetized after the time set by the timer 170 elapses, so that they are connected to the first through third star-delta terminals 123a, 123b, and 123c while being

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connected to the first through third delta connection contacts 125a, 125b, and 125c, thereby causing the three-phase motor M to be driven in a delta connection state.

The star-delta connection switching unit 160 also includes star-delta connection-end compression coil springs 165 arranged around the moving core 161 between the upper surface of the star-delta connection-end electromagnet 140 and the lower surface of the star-delta connection-end vertical moving member 162 in order to provide a return force for returning the vertical moving member 162 to its upper position. The star-delta connection-end compression coil springs 165 are arranged in pair in such a fashion that those of each pair are disposed at opposite sides of the star-delta connection-end electromagnet 140.

The star-delta connection-end compression coil springs 165 serve to always urge the star-delta connection-end vertical moving member 162 to move upwardly in a normal state. The star-delta connection-end compression coil springs 165 have an elastic coefficient lower than the magnetic force of the star-delta connection-end electromagnet 140 in order to allow the star-delta connection-end vertical moving member 162 to move downwardly against the urging force of the star-delta connection-end compression coil springs 165 when the star-delta connection-end electromagnet 140 is magnetized, thereby causing the three-phase motor M to be driven in a delta connection state.

Preferably, the main circuit switching unit 150 further includes star-delta connection-end damping springs 166 for damping impact generated when the first through third star connection-end moving members 167a, 167b, and 167c abruptly contact associated contact portions as the star-delta connection-end vertical

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moving member 162 moves upwardly by virtue of the urging force of the star-delta connection-end compression coil springs 165 while damping impact generated when the first through third star connection-end moving members 167a, 167b, 167c abruptly contact associated fixed contacts as the star-delta connection-end vertical moving member 162 moves upwardly by virtue of the magnetic force of the star-delta connection-end electromagnet 140, respectively. The star-delta connection-end damping springs 166 are arranged in the form of a plurality of sets each including three star-delta connection-end damping springs.

Since the magnetic force of the magnetized star-delta connection-end electromagnet 140 is higher than the elastic coefficient of the star-delta connection-end compression coil springs 165, the star-delta connection-end vertical moving member 162 may be abruptly lowered when the star-delta connection-end electromagnet 140 is magnetized, thereby generating impact or noise. To this end, the star-delta connection-end damping springs 166 are provided in order to damp impact or noise possibly generated when the first through third delta connection-end moving members 164a, 164b, and 164c connect the first through third delta connection contacts 125a, 125b, and 125c with the first through third star-delta terminals 123a, 123b, and 123c. Also, the star-delta connection-end damping springs 166 serve to damp impact or noise generated when the first through third star connection-end moving members 167a, 167b, and 167c connect the star connection plate 124 to the first through third star-delta terminals 123a, 123b, and 123c as the star-delta connection-end vertical moving member 162 moves abruptly in an upward direction by virtue of the urging force of the star-delta connection-end compression coil springs 165 in accordance with a

release of the magnetic force from the star-delta connection-end electromagnet 140.

The electromagnetic switch device C of the present invention is also internally provided with an anti-arc zinc-plated steel plate (not shown) adapted to inhibit generation of an arc during the switching operation of the main circuit switching unit 150 or star-delta connection switching unit 160.

In the drawings, the reference numeral 191 denotes terminals to which power lines are coupled in order to supply current to the coils 132 and 142. The reference numeral 192 denotes bolts respectively coupled to the terminals 191 in order to provide an easy connection of the power lines to the terminals 191.

The electromagnetic switch device C for star-delta connections having the above mentioned configuration operates in a selected connection state, as shown in the equivalent circuit diagram of FIG. 5, in such a fashion that it establishes a star connection, when it is desired to start up the electric motor M, in order to achieve a start-up of the electric motor M using starting current and starting torque reduced to a 1/3 level while switching the connection of the electric motor M to a delta connection after completion of the start-up of the electric motor M. For the best understanding of the present invention, elements of FIG. 5 respectively corresponding to those in FIG. 4 are denoted by the same reference numerals.

Now, the operation of the electromagnetic switch device C for star-delta connections according to the present invention will be described.

When current flows through the coil 132 of the main circuit-end electromagnet 130, which is constructed by the fixed core 131 and the coil 132, upon starting the three-phase electric motor M, the electromagnet 130

is magnetized by virtue of the current. Simultaneously with the magnetization of the electromagnet 130, the timer 170 begins to count the activation time of the electromagnet 130.

As the electromagnet 130 is activated, it generates a magnetic force greater than the urging force of the main circuit-end compression coil springs 155, so that the main circuit-end moving core 151 and main circuit-end vertical moving member 152 are downwardly moved. At the same time, the main circuit-end moving members 154a, 154b, and 154c are downwardly moved, thereby causing the first through third power terminals 121a, 121b, and 121c to be connected with the first through third main terminals 122a, 122b, and 122c, respectively.

In such an initial state, the star-delta connection-end electromagnet 140 is maintained under a non-magnetization condition, that is, a condition in which no current flows through the coil 142. Accordingly, the star-delta connection-end moving coil 161 and star-delta connection-end vertical moving member 162 are maintained in a state in which they are spaced away from the coil 142 by virtue of the resilience of the star-delta compression coil spring 165. In this state, the first through third star connection-end moving members 167a, 167b, and 167c, which move upwardly along with the star-delta connection-end vertical moving member 162, connect the star connection plate 124 to the first through third star-delta terminals 123a, 123b, and 123c the star connection-end moving contacts 167a, 167b, and 167c, thereby allowing the three-phase motor M to be start up in a star connection state.

Thus, the three-phase electric motor M can be stably started up in the initial state by electric power supplied via the three-phase power lines R, S, and T

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respectively connected to the power terminal 121a, 121b, and 121c.

After a predetermined period of time elapses, current flows through the coil 142 of the star-delta connection-end electromagnet 140 in accordance with an operation of the timer 170. By virtue of the current, the star-delta connection-end electromagnet 140 is magnetized.

As the electromagnet 130 is activated, it generates a magnetic force greater than the resilience of the star-delta connection-end compression coil springs 165, so that the star-delta connection-end moving core 161 and star-delta connection-end vertical moving member 162 are downwardly moved.

At the same time, the first through third star connection-end moving members 167a, 167b, and 167c are downwardly moved, so that they are separated from the star connection plate 124, thereby releasing the star connection state. Also, the delta connection-end moving members 164a, 164b, and 164c come into contact with the first through third delta connection-end contacts 125a, 125b, and 125c and the first through third star-delta terminals 123a, 123b, and 123c, thereby causing the three-phase motor M to be started up in a delta connection state.

Thus, the three-phase motor M initially has a star connection state, so that it is stably started up by electric power supplied via the three-phase power lines R, S, and T respectively connected to the power terminal 121a, 121b, and 121c. Following the start-up, the star-delta connection-end electromagnet 140 is magnetized, so that the first through third delta connection-end moving members 164a, 164b, and 164c connect the first through third delta connection-end contacts 125a, 125b, 125c with the first through third star-delta terminals 123a,

123b, and 123c, respectively, thereby allowing the three-phase motor M to be driven at a full speed.

Industrial Applicability

As apparent from the above description, the electromagnetic switch device according to the present invention has a configuration in which the timer 170 is contained in the body 110 so that it is integral with the body 110. Also, the electromagnetic switch device has a configuration in which the system for switching on and off the main power source and the system for switching the connection of the three-phase motor M between the star connection and the delta connection are contained in the body 110 so that they are integral with the body 110. By virtue of such configurations, the three-phase motor M can be stably and simply driven in a three-contact fashion.

That is, in the electromagnetic switch device according to the present invention, the timer 170 is contained in the body 110 while being integral with the body 110. Also, the electromagnetic switch device is configured to switch on and off the main power source by electronic switching operations conducted by the main circuit-end electromagnetic 130 and the main circuit-end vertical moving member 152. The electromagnetic switch device is also configured to selectively enable a star connection or a delta connection in accordance with the switching operation of the star-delta connection-end electromagnet 140 and the star-delta connection-end vertical moving member 162. Thus, it is possible to simplify the wiring required for desired connections, as compared to the conventional case. Moreover, it is possible to achieve improvements in assemblability and productivity while preventing erroneous connections, thereby obtaining an enhanced stability.

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Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

1. An electromagnetic switch device for star-delta connections comprising:

a body;

first through third power terminals arranged at one side portion of the body on an upper surface of the body and respectively connected to three-phase power lines;

first through third main terminals arranged at an intermediate portion of the body on the upper surface of the body and respectively connected to one-side terminals of a three-phase electric motor;

first through third star-delta terminals arranged at the other side portion of the body on the upper surface of the body and connected to the other-side terminals of the three-phase electric motor, respectively;

a star connection plate set on the upper surface of the body and adapted to connect the first through third star-delta terminals to a star circuit;

first through third contacts set beneath the star connection plate and adapted to connect the first through third star-delta terminals to a delta circuit;

a timer assembled to the body at a bottom of the body while being integral with the body, the timer serving to control a start-up time for the three-phase motor;

an electromagnet for a main circuit and an electromagnet for star-delta connections each including a fixed core and a coil assembled in the interior of the body, each of the electromagnets being selectively magnetized in accordance with a cooperation of the fixed core and coil thereof;

a main circuit switching unit assembled to an upper portion of the body at one side of the body so

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that it is integral with the body, the main circuit switching unit serving to selectively connect the first through third power terminals with the first through third main terminals, respectively, in accordance with the magnetization of the main circuit-end electromagnet; and

a star-delta connection switching unit assembled to the upper portion of the body at the other side of the body so that it is integral with the body, the star-delta connection switching unit serving to connect the star connection plate to the first through third star-delta terminals in accordance with the magnetization of the main circuit-end electromagnet under a condition in which the first through third power terminals are connected with the first through third main terminals, thereby allowing the three-phase motor to be start up in a star connection state, the star-delta connection switching unit also serving to connect the first through third delta connection contacts to the first through third star-delta terminals when the star-delta connection-end electromagnet is magnetized in accordance with an operation of the timer after the start-up of the three-phase motor, thereby causing the three-phase motor to be driven in a delta connection state.

2. (Deleted)

3. (Deleted)

4. (Deleted)

5. The electromagnetic switch device according to claim 1, wherein the star-delta switching unit comprises:

a star-delta connection-end moving core adapted to

move vertically in accordance with a magnetization of the star-delta connection-end electromagnet;

a star-delta connection-end vertical moving member integrally coupled to the star-delta connection-end moving core and adapted to move vertically along with the star-delta connection-end moving core;

first through third star connection-end moving members adapted to move upwardly along with the star-delta connection-end vertical moving member in accordance with a magnetization of the main circuit-end electromagnet under a condition in which the first through third main terminals are connected to the first through third power thermals, so that they are connected to the first through third star-delta terminals while being connected to the star connection plate, thereby allowing the three-phase electric motor to be started up in the star connection state; and

first through third delta connection-end moving members adapted to move downwardly along with the star-delta connection-end vertical moving member when the star-delta connection-end electromagnet is magnetized after a time set by the timer elapses, following the start-up of the three-phase electric motor in the star connection state, so that they are connected to the first through third star-delta terminals while being connected to the first through third delta connection contacts, thereby causing the three-phase electric motor to be driven in the delta connection state.

6. The electromagnetic switch device according to claim 1, wherein the star-delta switching unit further comprises:

star-delta connection-end compression coil springs adapted to always urge the star-delta connection-end vertical moving member to move upwardly, thereby

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allowing the three-phase electric motor to be started up in the star connection state, the star-delta connection-end compression coil springs having an elastic coefficient lower than a magnetic force of the star-delta connection-end electromagnet to allow the star-delta connection-end vertical moving member to move downwardly against the urging force of the star-delta connection-end compression coil springs when the star-delta connection-end electromagnet is magnetized, thereby causing the three-phase electric motor to be driven in the delta connection state, the star-delta connection-end compression coil springs being arranged in pair so that those of each pair are disposed at opposite sides of the star-delta connection-end electromagnet, respectively; and

star-delta connection-end damping springs for damping impact generated when the first through third star connection-end moving members abruptly contact associated contact portions as the star-delta connection-end vertical moving member moves upwardly by virtue of the urging force of the star-delta connection-end compression coil springs while damping impact generated when the first through third star connection-end moving members abruptly contact associated fixed contacts as the star-delta connection-end vertical moving member moves upwardly by virtue of the magnetic force of the star-delta connection-end electromagnet, respectively, the star-delta connection-end damping springs being arranged in the form of a plurality of sets each including three star-delta connection-end damping springs.

7. (Deleted)

FIG . 1a

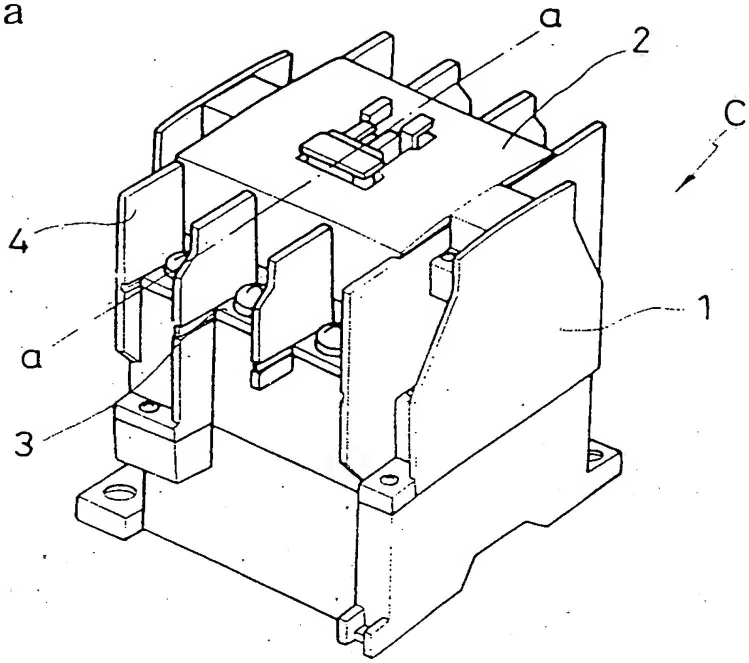

FIG . 1b

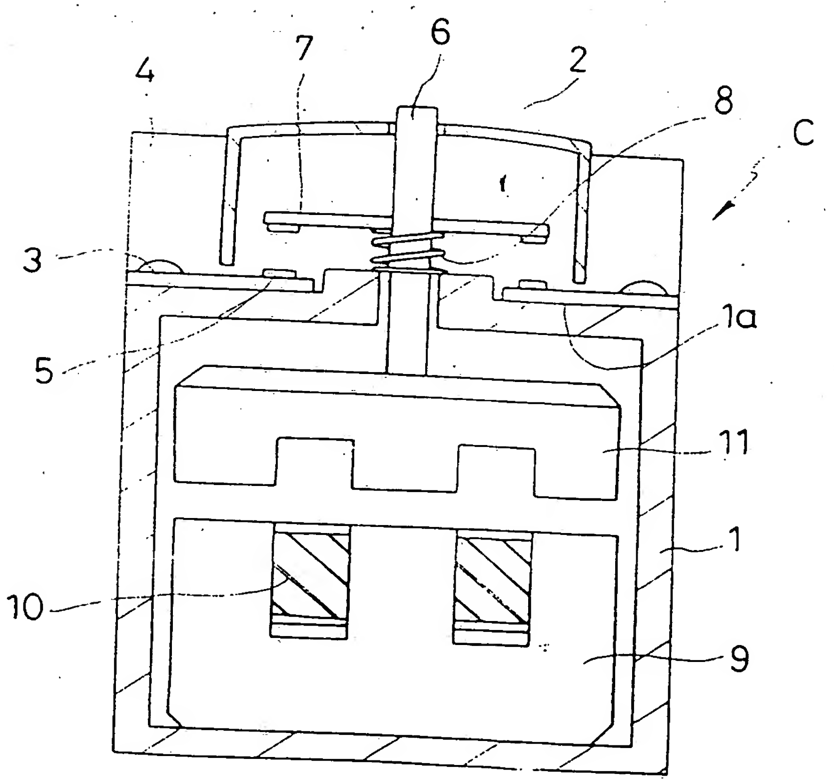

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FIG . 2

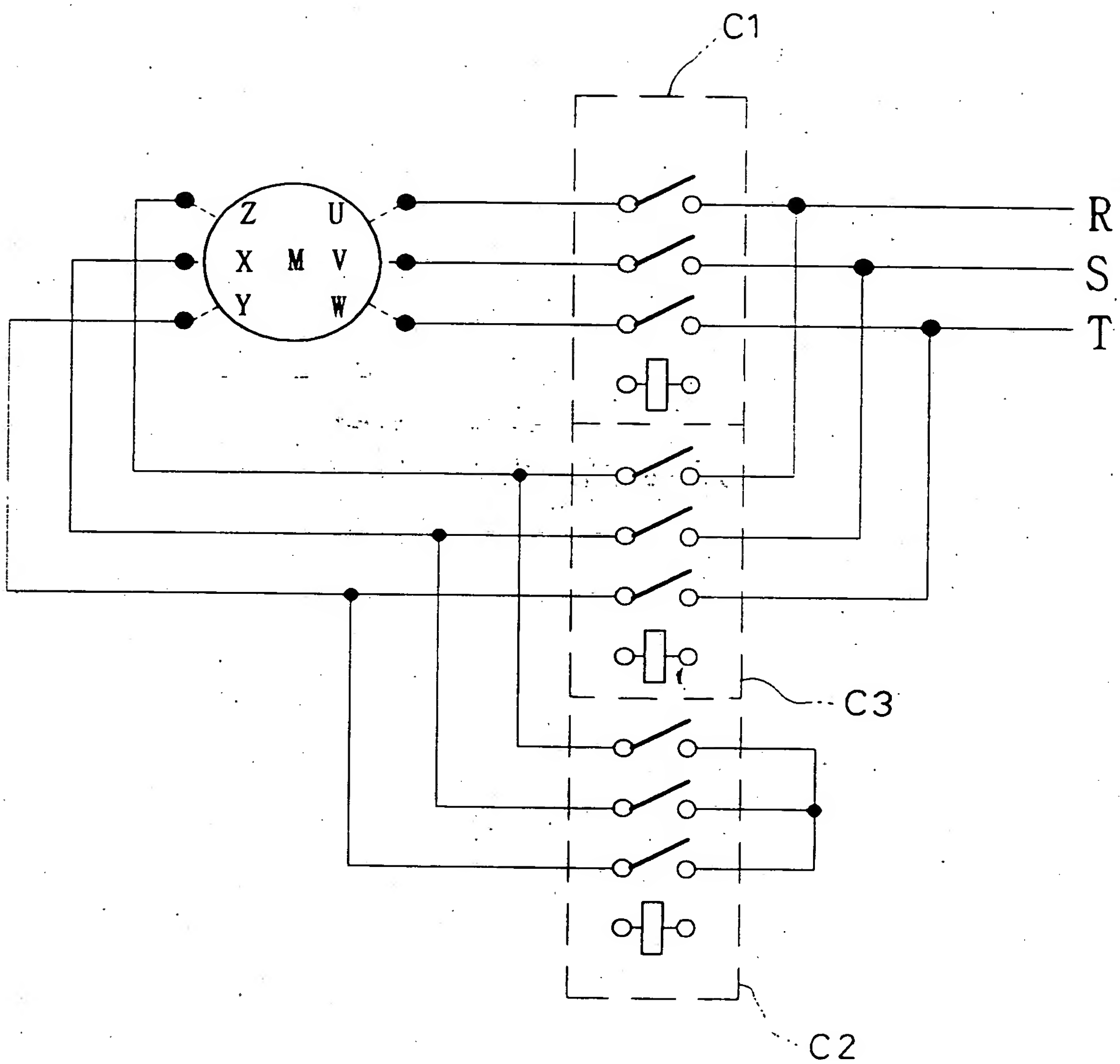

FIG . 3a

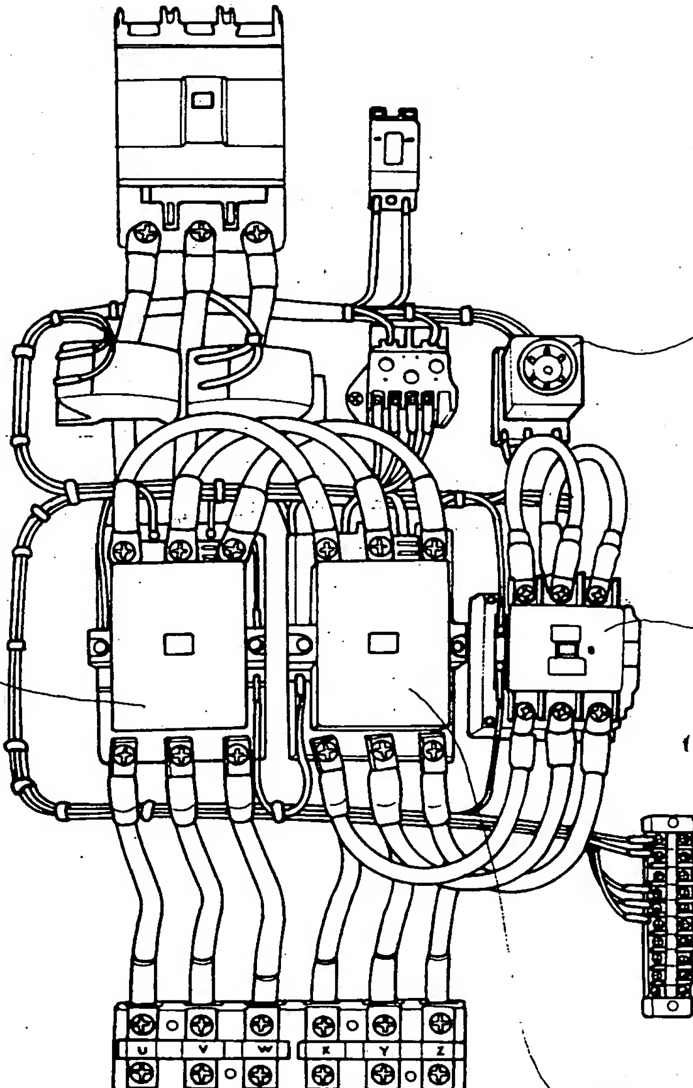

FIG . 3b

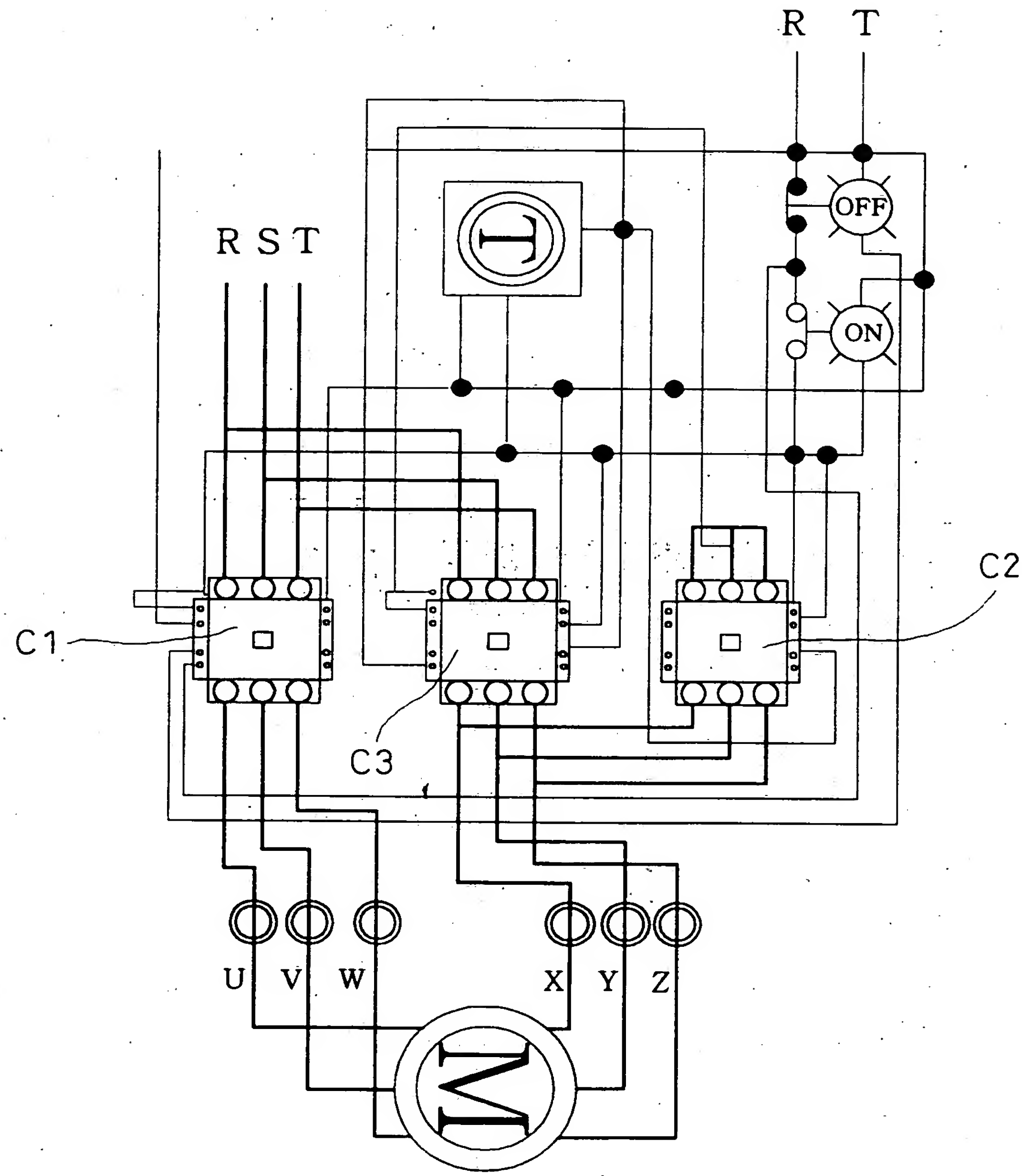

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FIG . 4

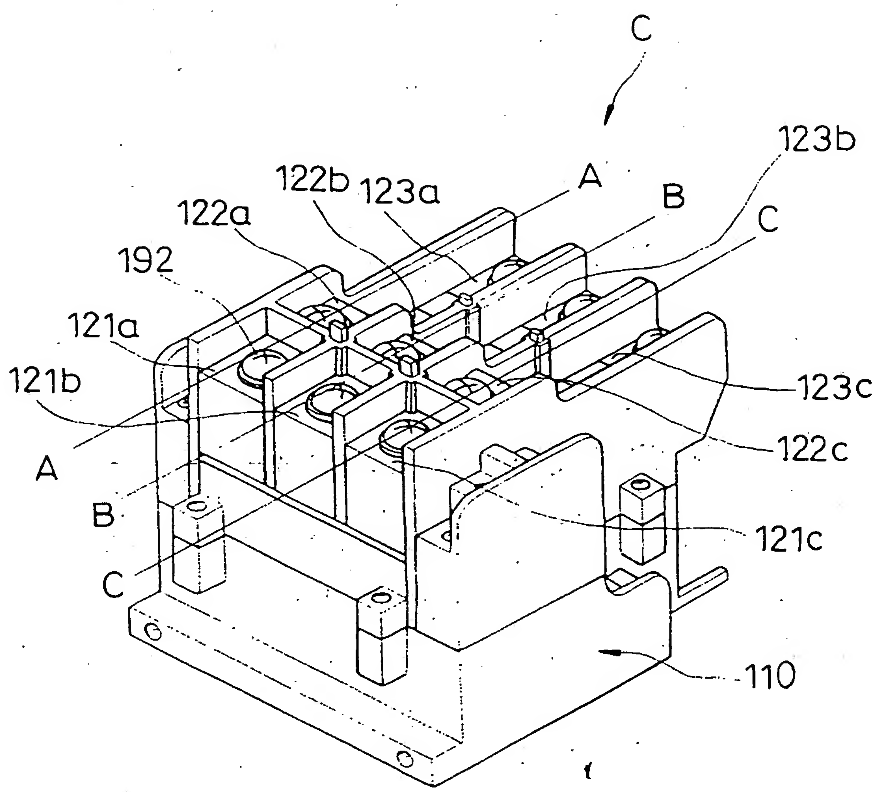
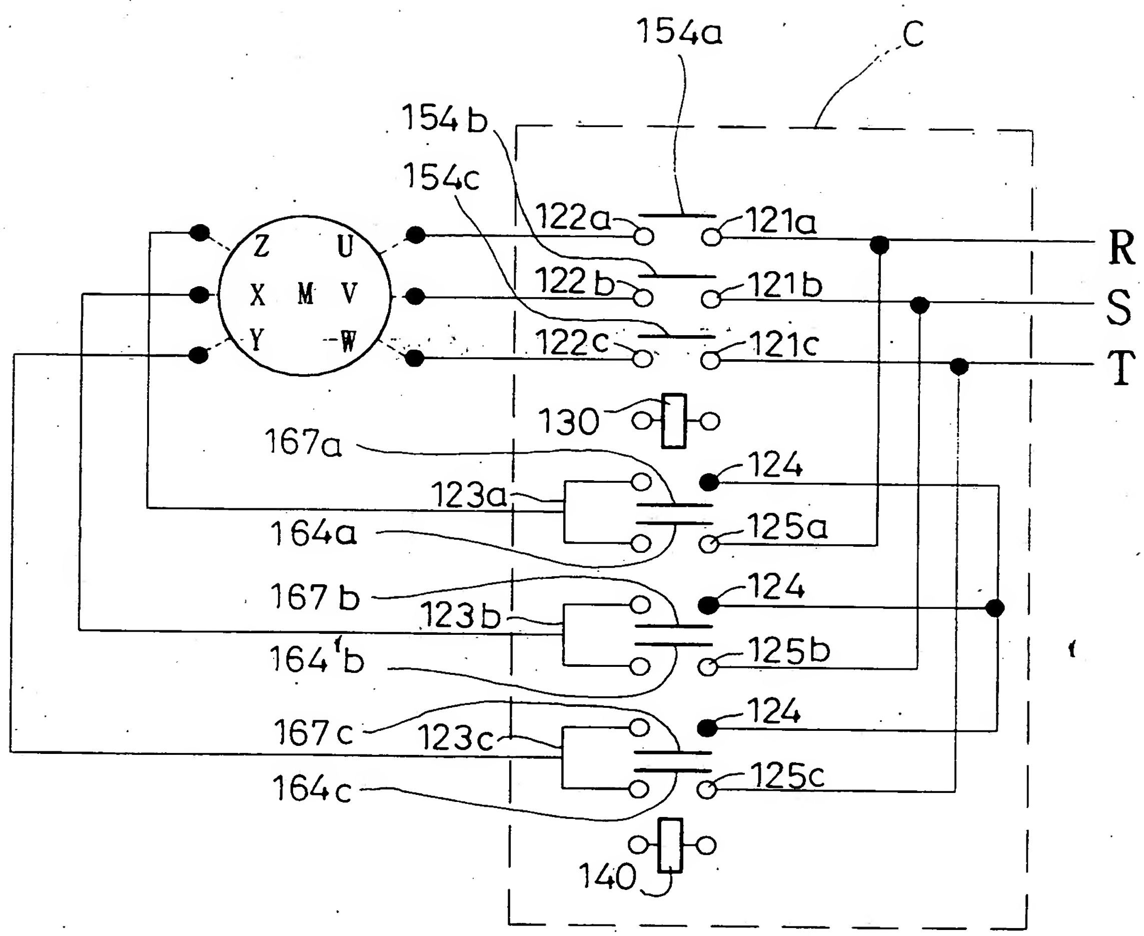


FIG . 5


154a
C
154b
154c
122a
121a
R
Z
U
X
M
V
Y
W
122b
121b
S
122c
121c
T
130
167a
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164a
125a
167b
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123b
164b
125b
167c
124
123c
164c
125c
140

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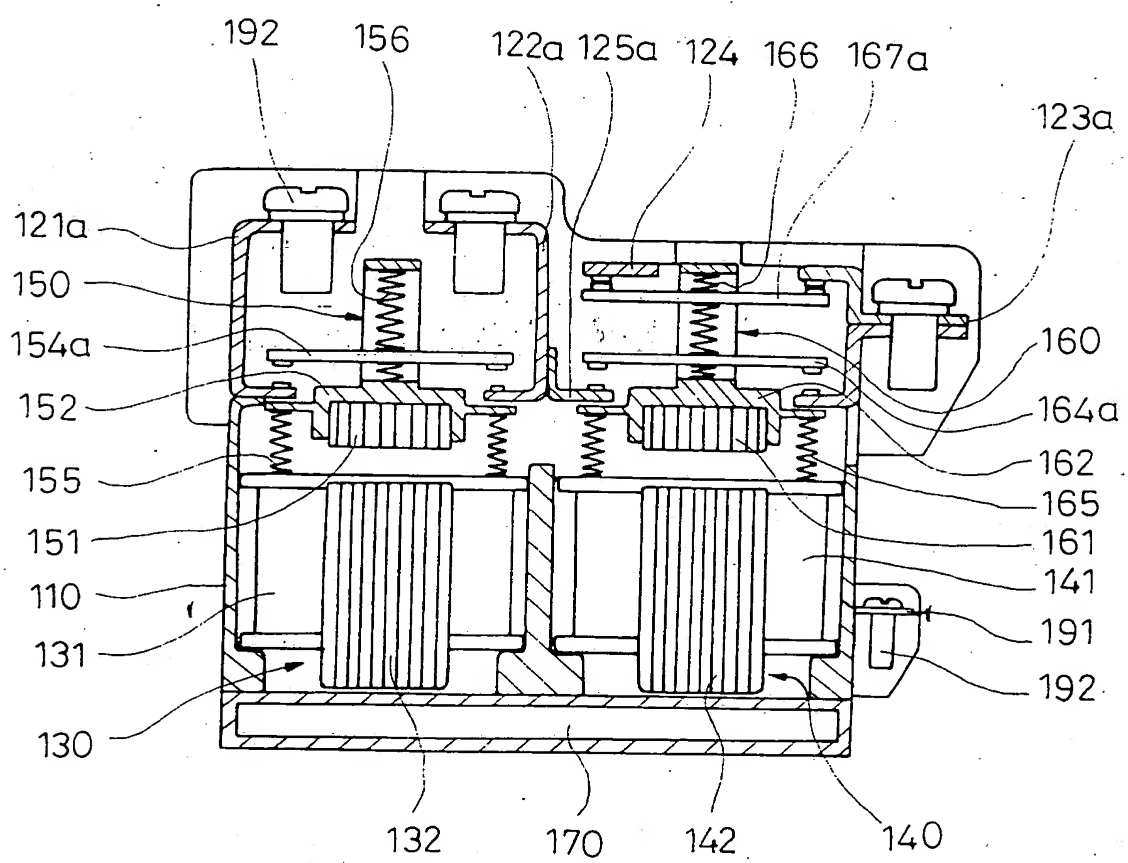
FIG . 6a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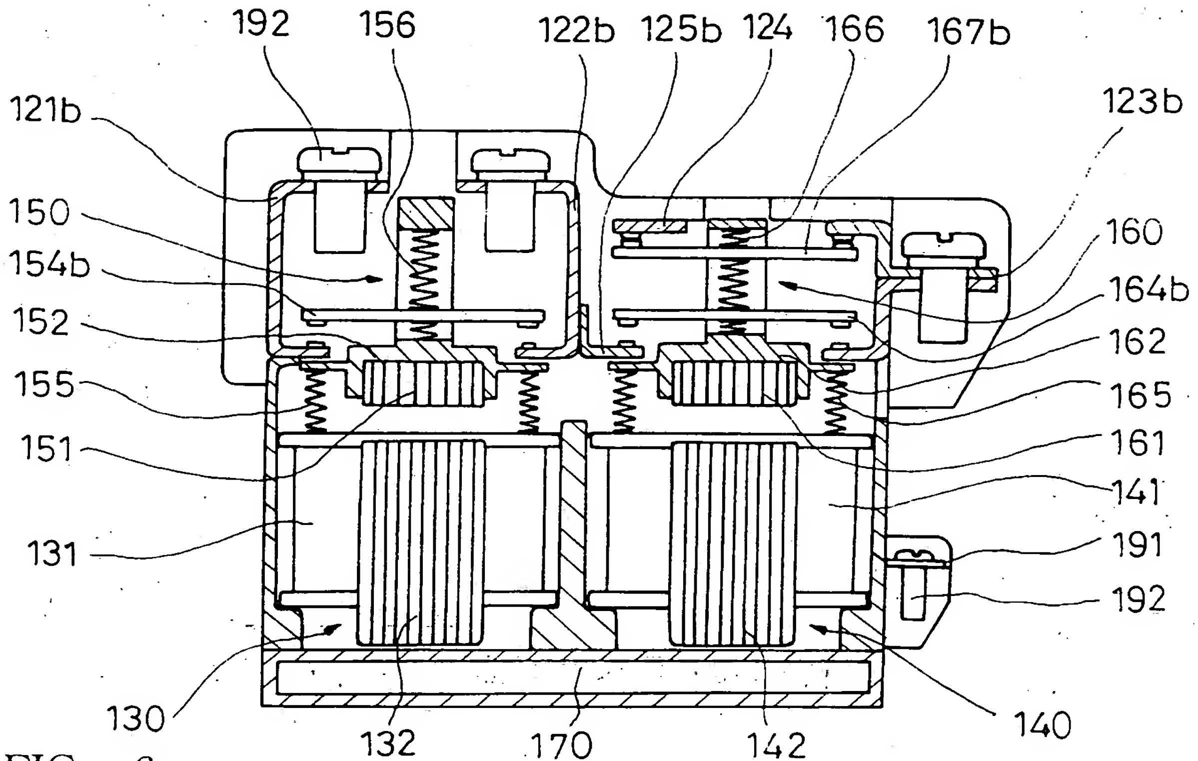
122a
125a
124
166
167a
123a
121a
150
154a
152
155
151
110
131
130
160
164a
162
165
161
141
191
192
132
170
142
140

FIG . 6b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122b
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166
167b
121b
123b
150
160
154b
164b
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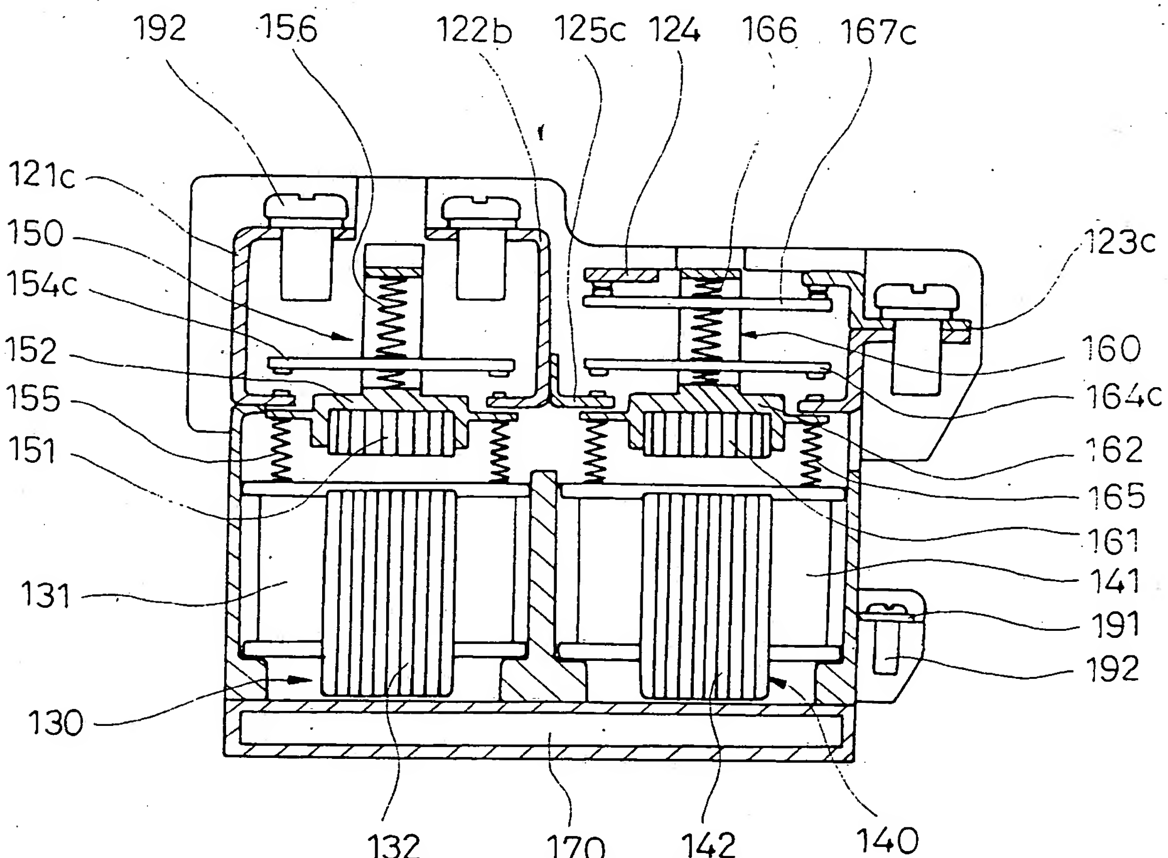
162
155
165
151
161
141
131
191
192
130
132
170
142
140

FIG . 6c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122b
125c
124
166
167c
121c
150
154c
123c
160
152
164c
155
162
151
165
161
141
131
191
192
130
132
170
142
140

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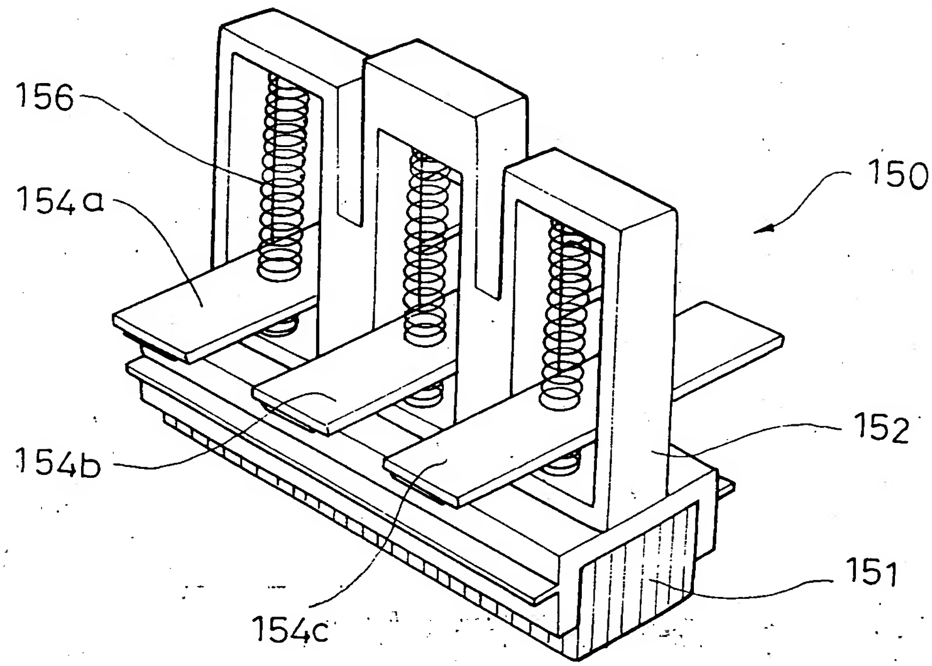
FIG . 7a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154a
150
152
154b
151
154c

FIG . 7b

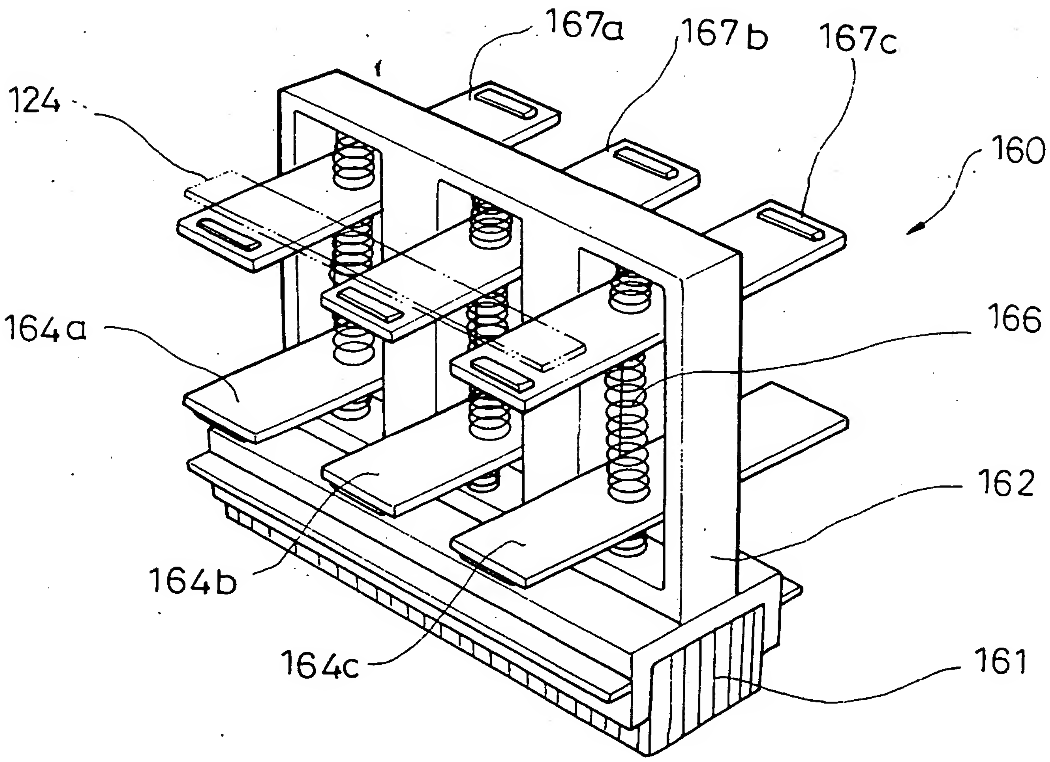
167a
167b
167c
124
160
164a
166
162
164b
161
164c

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FIG . 8a

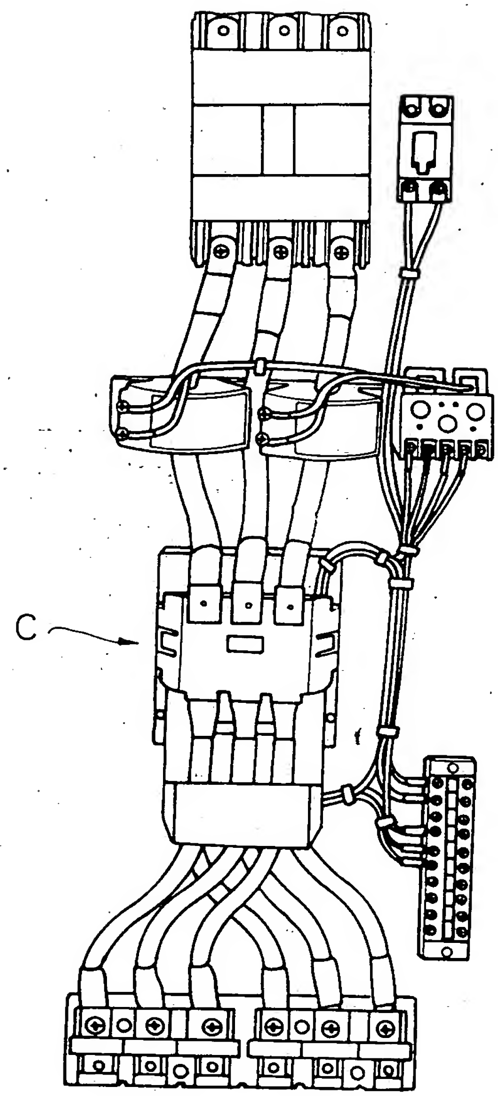
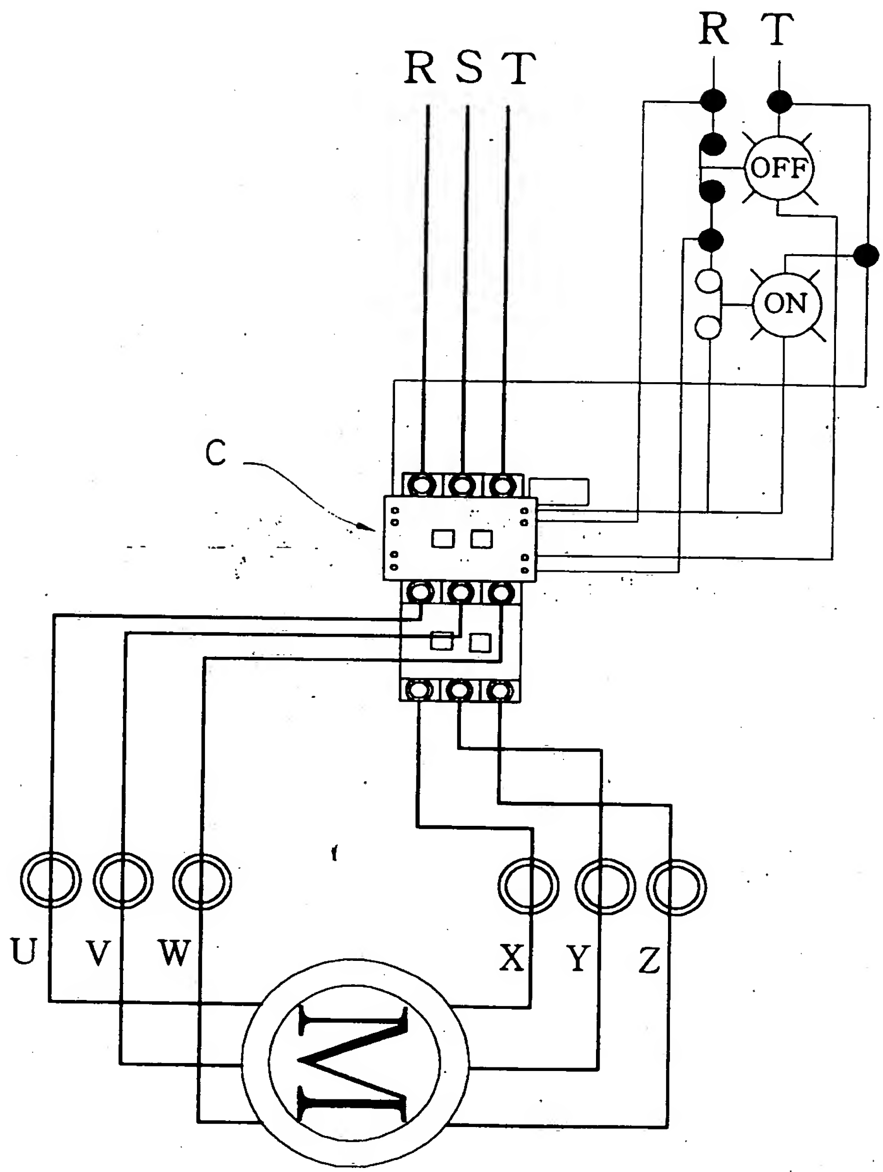


FIG . 8b



PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
LEE, Man Jae 3rd Fl., Woosung Bldg., 827-47, Yeoksam-dong, Kangnam-gu, Seoul 135-080, Republic of KOREA

PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	30 AUGUST 2001 (30.08.2001)

Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
00-PCT-001	

International application No.	International filing date *(day/month/year)*	Priority date *(day/months/year)*
PCT/KR00/00039	20 JANUARY 2000 (20.01.2000)	11 MAY 1999 (11.05.1999)

Applicant
INTERVENTION CO., LTD

1. The applicant is hereby notified that International Preliminary Examining Authority transmits here with the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report(but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details in the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon. Dunsan-dong. Seo-gu. Daejeon Metropolitan City 302-701. Republic of Korea	COMMISSIONER
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5210

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Artcle 36 and Rule 70)

Applicant's or agent's file reference 00-PCT-001	**FOR FURTHER ACTION**	SeeNotificationofTransmittalofInternationalPreliminary Examination Report (Form PCT/IPEA/416)
International application No. **PCT/KR00/00039**	International filing date*(day/month/year)* 20 JANUARY 2000 (20.01.2000)	Priority date *(day/month/year)* 11 MAY 1999 (11.05.1999)

International Patent Classification (IPC) or national classification and IPC **IPC7 H01H 50/00**
Applicant INTERVENTION CO., LTD

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 38 sheets.

3. This report contains indications relating to the following items:

I	[X]	Basis of the report
II	[ ]	Priority
III	[ ]	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	[ ]	Lack of unity of invention
V	[X]	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	[ ]	Certain documents cited
VII	[ ]	Certain defects in the international application
VIII	[ ]	Certain observations on the international application

Date of submission of the demamd 20 JANUARY 2000 (20.01.2000)	Date of completion of this report 29 AUGUST 2001 (29.08.2001)
Name and mailing address of the IPEA/KR Korean Intellectual Property Office Government Complex-Daejeon. Dunsan-dong, Seo-gu. Daejeon Metropolitan City 302-701. Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer BAK, Junyung Telephone No. 82-42-481-5729

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International aplication No.
PCT/KR00/00039

I. Basis of the report

1. With regard to the elements of the international application:*

- [ ] the international application as originally filed
- [X] the description:
  - pages ______ , as originally filed
  - pages ______ , filed with the demand
  - pages 1-22 , filed with the letter of 20/03/2001 (20/07/2001)
- [X] the claims:
  - pages ______ , as originally filed
  - pages ______ , as amended (together with any statment) under Article 19
  - pages ______ , filed with the demand
  - pages 23-26 , filed with the letter of 20/03/2001 (20/07/2001)
- [X] the drawings:
  - pages ______ , as originally filed
  - pages ______ , filed with the demand
  - pages 1/11-11/11 , filed with the letter of 20/03/2001(20/07/2001)
- [ ] the sequence listing part of the description:
  - pages ______ , as originally filed
  - pages ______ , filed with the demand
  - pages ______ , filed with the letter of ______

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language English which is

- [ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- [X] the language of publication of the international application(under Rule 48.3(b)).
- [ ] the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/ or 55.3).

3. With regard to any **nucleotide** and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- [ ] contained inthe international application in written form.
- [ ] filed together with the international application in computer readable form.
- [ ] furnished subsequently to this Authority in written form.
- [ ] furnished subsequently to this Authority in computer readable form
- [ ] The statement that the subsequently furnished written sequence listing does not go beyond the disc losure in the international applicationas as filed has been furinshed.
- [ ] The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. [X] The amendments have resulted in the cancellation of:
   - [ ] the description, pages ______
   - [X] the claims, Nos. 2-4, 7
   - [ ] the drawings, sheet ______

5. [ ] This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box(Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed." and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International aplication No.
PCT/KR00/00039

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1, 5, 6	YES
	Claims		NO
Inventive step (IS)	Claims	1, 5, 6	YES
	Claims		NO
Industrial applicability (IA)	Claims	1, 5, 6	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

This statement is based on the amended claims 1, 5, 6 filed on March 20, 2001 with the letter of July 20, 2001.

The claimed invention relates to an electromagnetic switch device designed to be used for a star-delta starter adapted to start up a three-phase electric motor. The electromagnetic switch device is configured to switch on and off a main power source by electric switching operations conducted by a main circuit-end electromagnet and a main circuit-end vertical moving member. It is also configured to selectively enable a star connection or a delta connection in accordance with the switching operation of a star-delta connection-end electromagnet and a star-delta connection-end vertical moving member.

None of the documents in the International Search Report (ISR), taken alone or in combination, discloses the special combination of features defined in the invention. Furthermore, in the ISR documents there are no suggestions leading a person skilled in the art towards the invention defined by amended claims 1, 5, 6. Therefore. the invention is novel, involves an inventive step, and has industrial applicability.